In This Issue: "The Improvement of the Ohio River: What It Pays."—Recent Designs of Concrete Railway Ties.—The "Governor Reynolds" Concrete Arch, Province of Albay, P. I.—Engineering Literature Supplement.

ENGINEERING NEWS

Founded 1874. Volume 63. No. 7.

220 Broadway, NEW YORK, THURSDAY, FEBRUARY 17, 1910.

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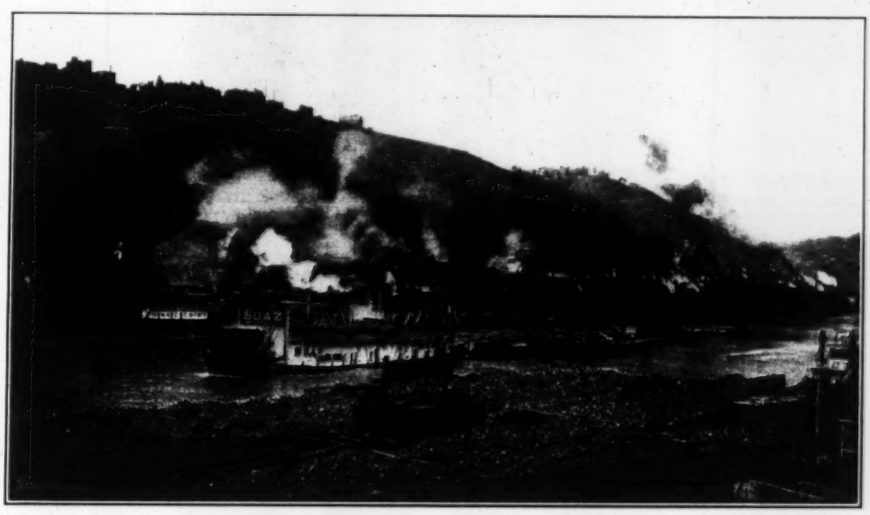
Some Practical Views as to Transportation on Western Rivers.

By THOMAS P. ROBERTS.*

The report of the Board of Engineers on the project for a 14-ft. deep waterway from the Lakes to the Gulf,† presents much data relating not only to the feasibility but as well to the commercial value of such an undertaking. The report is very complete in its description of the principal Western rivers and calls attention to the facts, long known to the U. S. Engineers, that the Mississippi from St. Louis to Cairo and from Cairo to New Orleans, has a deeper and safer channel and fewer snags than ever before. Also, that the Ohio River from Pittsburg to Cairo, is much safer and with somewhat better depth than in early times.

These improvements to the natural channels of the rivers named are solely due to the work of the U. S. Engineers in river bank protection along the Mississippi below Cairo, and to dikes and occasional dredging operations on the Ohio and Mississippi rivers. That these rivers to-day are less impeded with silt, snags, etc., than formerly is a fact apparently unknown to the newspaper and magazine writers who persistently assert to the contrary.



DEPARTURE OF COAL FLEETS FROM PITTSBURG. (REPRODUCED FROM "REPORT OF OHIO RIVER BOARD").

The view shows one of the larger tow-boats used on the Ohio above Louisville. Length, 193 ft.; beam, 44.4 ft.; depth of hold, 6.5 ft.; maximum horse-power with 15 revolutions of wheel per minute, 1,620; two engines; cylinders, 28 ins., 8-ft. stroke; gross tonnage 623; battery, 6 boilers, 40 ins. diameter, 28 ft. long, each with two 14-in. flues; allowed pressure, 181 lbs.; wheel, 28-ft. diameter, 28 ft. long, 16 buckets, each 3 ft. wide. Such a boat handles 25,000 to 30,000 tons of coal in fleets.

Reasons for Decline in the River Traffic.

The report of the Board referred to gives for the minimum navigable draft of vessels on the Mississippi, Gulf to New Orleans, Baton Rouge, and Bayou Sara, 270 miles, 25 to 30 ft. Thence 840 miles to Cairo, mouth of the Ohio River, 9 ft. Thence 8-ft. depth, 182 miles, Cairo to St. Louis, with 365 miles up the Mississippi and Illinois rivers and through the Illinois state canal to Chicago, 4½ ft. permissible draft.

For the Ohio, Cairo to Pittsburg, 967 miles, there are weeks at a time, during some seasons, near its upper end, that the navigable depth may be even less than 2 ft., although in descending the river the periods of such extreme low water are shorter in duration and for several consecutive years may not occur at all.

The conclusion by the Board that we have several thousand miles of navigation in the Mississippi Valley with a greater available depth than the rivers of Europe is justified by the facts, yet while in Europe river transportation competes successfully with the railroads, in our country the river traffic (excepting for the upper Ohio and Monongahela rivers) has tended to decline. The cause of this decline in traffic in the face of improved river conditions in America, is a matter of much concern at this time when United States bond issues are being so urgently called for by the friends of the rivers for their further betterment.

It certainly seems curious that with a 9-ft. depth, Cairo to New Orleans, about 1,100 miles, and only an insignificant freight movement to take advantage of it, there should be such a widespread desire to extend the same perennial depth to Louisville, Cincinnati and Pittsburg on the Ohio. It is an anomalous situation indeed where 1,100 miles of 9-ft. depth must await the improvement of a shallow, erratic tributary, 967 miles long, before its commercial value can be demonstrated. Stranger still that the erratic Ohio, especially at its extreme upper end, where automobiles occasionally ford the stream to escape bridge tolls, should be the chief commercial tributary of the mighty Mississippi.

No very satisfactory explanation of the peculiar situation that militates so greatly against the rivers has yet appeared in print. The failure of the Anchor Line of barges, engaged several years ago in the movement of bulk grain from St. Louis to New Orleans for transshipment to Europe, is still remembered. Again, aphorisms like "the clock has struck 12 for the Mississippi" are heard at banquets, but it is recalled that the Great Lakes were likewise doomed by the same merrymakers only a few years ago when "the locomotive was hot on the trail of the 20-ft.-draft-steamer."

Entirely too much importance "in the race for supremacy" has been attached by the landsmen to the matter of draft of boats on rivers. Double-tracked level railroads line both banks of the Monongahela. Nevertheless coal is shipped from the mines to mills along its banks in boats of 6 and 7-ft. draft for less than one-third the lowest rail rates. The distinction between canals and rivers, on which latter freight can be moved in large fleets of cheaply constructed boats,* is something never considered by the transportation orators.

Reverting to the Anchor Line failure, the mistakes of the company were chiefly in the administration department, such as failure to secure binding agreements with the trunk line roads centering at St. Louis and failure to appreciate the fact that New Orleans was not another New York in European trade, with great ocean steamers ever at command and often carrying grain in bulk almost as free ballast.

The sun of New Orleans can never be eclipsed, with the Mississippi and its improved affluents bringing down products to exchange for products from both coasts of South America, our own Pacific coast, and the Orient after the opening of the Panama Canal. Such an opinion may be deemed highly optimistic, but if it errs, the construction of the Panama Canal for American commercial interests is a most egregious blunder. There were other mistakes as to draft of many of the barges in the Anchor Line, attempts to use propellers in towing, etc., which contributed to the failure. But such errors could have been corrected in time. Curiously enough, nearly all the Anchor Line boats were sent to Pittsburg and sold to shippers who still keep them in use.

The valley in the vicinity of the river, Cairo to New Orleans, was formerly in a great measure undeveloped swamp land, or land subject to overflow, but, nevertheless, of unbounded fertility compared with which the Nile Valley

*U. S. Engineer Office, Pittsburg, Pa.

†Published in Engineering News of Nov. 4, 1909.

*Existing types of wooden boats on the Ohio cost about $2 to $3 per ton capacity, or, if of steel, latest model, will cost about $6 to $7 per ton. It is quite evident that a fleet of ten such boats, each of 1,000 tons capacity, can be operated with much less capital investment than the single lake or seaworthy barge of 10,000 tons capacity, which could probably not be produced for less than $15 per ton.

is only a miniature prototype. The region, however, has been largely protected at considerable cost after the manner of the operations in Holland. In short, no one denies its fabulous agricultural resources and that it will be more fully developed to meet the demands of the growing millions of our population. In a few decades it promises to yield vast quantities of produce from a soil which, with intelligent usage, can never be exhausted, and so we may say its past commercial value is slight compared with its potential value as a freight producer. The railways back from the rivers have taken most of the freight that was produced, leaving listless communities to linger on the river banks. There are no towns on the map so dead as river towns after steamboat navigation ceases. Even double-tracked railroads through them cannot restore them to life; they must hear the whistle "round the bend" before they can be revived.

The halcyon days of palatial Mississippi River steamers carrying large crews of cooks, waiters, cabin boys, deckhands, and roustabouts, with their wide cantilever guards flat on the water with a few hundred tons of cotton bales have, with railway competition, become things of the past. With a barge system in fleets, permissive of crews averaging not much over one man to the thousand tons cargo capacity, there will be an entirely different proposition for consideration.

For the Ohio the natural conditions differ radically in every respect from the Mississippi Valley. The rock exposure on the hills about Pittsburg are more than 6,000 ft. above the silurian outcrop along the continental anticlinal which crosses the Ohio at Cincinnati. As the lower rocks exhibit themselves in regular gradation above the water surface in going down the river there is successively exposed the coal, oil, and gas seams; limestone, brick, tile, and pottery clays; salt, iron ore, and cement rock in great variety for busy men to delve into. Below Cincinnati it is interesting to know that the same rocks, generally speaking, reappear, but in reverse order, on the western slope of the great anticline, the coal measures outcropping below Evansville. These are all mostly minerals of low intrinsic value, but as they are not found in the vast alluvial plain below to the Gulf, their products are in demand even now and the demand must continue to increase in the future. Their low value, however, demands the cheapest transportation. This is to say nothing of the cognate industries which nestle near the coal mines and are also interested in cheap transportation for some of their products. Arkansas, Louisiana, Texas, Mexico and the Gulf ports are the natural outlets for the products of the Ohio mines and mills, all very distant, to which shipments are only made by railroads by reason of the unreliability of the waterway and for no other reason.

The transportation philosophers are hugging a delusion in assuming that artificial highways can ever distance the "lines of least resistance" formed by improved rivers, and nothing is more foolish than the opposition of certain pseudo-political economists to the proper unfolding of every transportation resource, be it by rivers or canals, for along with these latter come the great communities which need the railways in many directions which the waterways cannot serve. Molasses jugs for nearly a hundred years past have been sent from the Monongahela Valley to New Orleans in small boat-load lots. Imagine such jugs to be sent by rail on the shortest possible routes to the same destination; their market value would be very likely consumed in freight charges. Occasionally also under peculiarly favorable river conditions, molasses and sugar are sent upstream, New Orleans to Pittsburg, 2,020 miles, for $2.50 per ton, whereas by carload lots the charge is $6 per ton. Such incidents are mentioned as tending to show there is a field open for waterways as distributers of commodities in the Mississippi Valley that is poorly served now. At present it may be stated that vessel owners leaving New Orleans for the Ohio Valley can give shippers of valuable southern produce no guarantee as to time of delivery. Only those that buy outright in the southern markets, dispense with insurance and assume all risks, can afford to take advantage of the low rates by river occasionally presented by the masters of the towboats.

Transportation Methods on the Ohio: The Balanced Rudder.

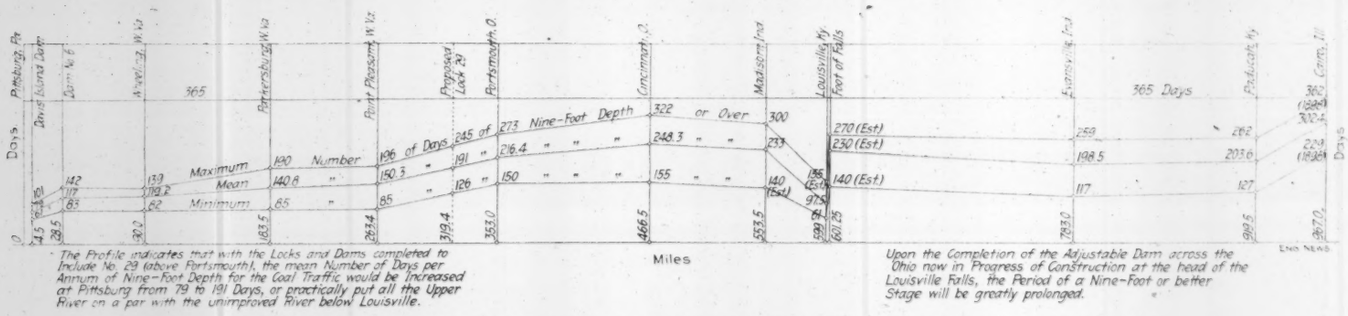
Between three and four million tons of coal, besides two hundred thousand or more tons of steel and other manufactured products, are annually sent down the Ohio from Pittsburg. This freight is carried in open barges of 500 tons each, and in open boats of 1,000 tons, while the steel, iron, glass, etc., is shipped in covered boats of 1,000 to 1,500 tons capacity. The barges are usually of 7-ft. and other boats 8 to 9-ft. draft. This freight is taken in fleets, often with aggregate cargoes of 15,000 tons, while much larger fleets are sometimes taken out at higher stages of the river. For the 7-ft. barges a channel depth of 9 to 10 ft. is demanded and for the heavier boats 11 to 13 ft. depth is required in the interest of safety for fleets covering large areas of water.

The average number of days that heavy draft, or "New Orleans fleets," can be moved from Pittsburg, based on ten years' records, is only 79, but as can readily be imagined, the periods of these navigable freshets are extremely irregular. Somtimes from May to the middle of December there may not be a single day that any kind of fleet can be moved from the harbor. On several occasions more than a million tons of freight, covering 200 acres of water with boats, have been accumulated, requiring an expenditure of $2,000 daily in pumping to keep them afloat. When a favorable stage at last arrives, more than 300,000 tons of freight may be shipped out in 24 hours.

While there are usually current velocities of from four to five miles an hour at boating stages, it would be quite a mistake to assume that the fleets could be turned adrift to float to their destinations. There are many islands and bars in the rivers and the water separating and reuniting about them, results in the formation of cross currents and eddies, so that great skill must be exercised by the pilots to keep their cumbrous fleets from being driven ashore. It would be impossible to tow these fleets astern as is done on the Detroit and Hudson rivers steam-propeller boats.

On the Ohio the fleets must be pushed and has been found after repeated trials with pr pellers and side-wheel boats that none of the can compare with the stern-wheel boat equipp with balanced rudders. The number of thes peculiar rudders may be three or more, accord ing to the width and power of the boats, in ad dition to the ordinary wing rudders at the ster corners of the hull. The balanced rudders are o steel and vary from 20 to 30 ft. in length, th forward half accommodated to the curved rak of the hull, and the after half extending toward and partly beneath the stern wheel and curve to the wheel's radius. When it is desired, in th least possible time, to change the direction o movement of the fleet, the stopping bell is rung next the backing signal is given, full steam or half steam, as the case demands; and at the same time the row of rudders is deflected so as to receive the full force of the reversed current direct from the wheel with the least possible dissipation of its energy. Headway in nearly all types of steam vessels, excepting western river towboats, is necessary to obtain effective steering power, but on the river towboats steering power is available whether the boat is moving forward, backward, or standing still, but is most effective when the boat is backing. As an average Ohio River fleet is about 750 ft. long, with the steamer's wheel usually 400 ft. from the center of gravity of the moving mass, a few hundred horse-power at the steering end amounts to thousands of effective horse-power in turning the fleet in the desired direction. The diagram of a medium-sized Ohio River fleet shows the curious arrangement of stay lines and position of the ratchet screws, which are used to lash and clamp the fleet into a rigid mass. An idea of the force developed by the rudders may be understood when it is known that the strains exerted on the heavy chains and ratchets (used to prevent the bending of the fleet) holding the front and second rows of boats in rigid alinement, sometimes snaps the chains, and secondary lashings of hemp cables are used to keep the fleet from being torn apart in such emergencies. It is known that the application of balanced rudders to Ohio River towboats about 1872, immediately doubled the "towing" capacity of the steamers in use, in fact revolutionizing the business, making it safer and greatly reducing the chances of being forced aground in the presence of powerful cross currents or heavy side winds.

By backing their wheels, steamers leaving the locks on the Monongahela River are enabled to quickly avert danger of collisions with other boats which may be approaching the open lock chambers. Certainly not more than one-third the number of lockages in a given time in both directions would be possible on the Monongahela with any other than stern-wheel pushboats equipped with balanced rudders. So it comes that the Ohio River navigators have developed a transportation system best adapted to the river's peculiar needs. Mention should be made of the fact that all Ohio River towboats are equipped with steam-steering gear, enabling deflections of the rudders to be made in much less time than



The Profile indicates that with the Locks and Dams completed to include No. 29 above Portsmouth, the mean Number of Days per Annum of Nine-Foot Depth for the Coal Traffic would be Increased at Pittsburg from 79 to 191 Days, or practically put all the Upper River on a par with the unimproved River below Louisville.

Upon the Completion of the Adjustable Dam across the Ohio now in Progress of Construction at the head of the Louisville Falls, the Period of a Nine-Foot or better Stage will be greatly prolonged.

DIAGRAM SHOWING PORTION OF THE YEAR THE OHIO RIVER IS AT OR ABOVE A NINE-FOOT STAGE.

Based on records of ten years, 1895 to 1905, except as follows: Portsmouth, O., five years, 1900 to 1905; Madison, Ind., five years, 1900 to 1905. Louisville, Ky. (below falls), five years, 1900 to 1905; Paducah, Ky., five years, 1900 to 1905.

formerly, and greatly diminishing liability to accident in sudden emergencies.

Speed of Fleets.

Loaded fleets from Pittsburg reach Cincinnati, 468 miles, in from 3½ to 4 days, and can return with partly loaded, or empty boats, in about the same time, the advantage of the downstream current being consumed in backing or flanking operations, whereas up-bound fleets move with full speed ahead all the time, hugging the shores, when it is safe to do so, to take advantage of the eddies. Round trips from Louisville to New Orleans, with the large steamers employed on the lower river, have often been accomplished in 22 days, or about 130 miles daily. Seven miles per hour downstream and three miles per hour breasting the currents of the Mississippi, upward bound, is about the limit on that river for towboats with fleets.

The annual average speed, estimated for full loaded fleets downstream and quarter loaded upward on the improved Ohio, is estimated at about five miles per hour for both directions. In this estimate, account has been taken of the reduced number of lockages along the middle and lower divisions of the river, where the dams will be down for several months longer than on the upper third, and of the fact that with the dams raised the currents will be so much reduced that little time will be lost by descending steamers in backing their wheels.

The fleets on the improved Ohio should be able to pass through the locks, 600 ft. × 110 ft., unbroken, which will indicate ten to twelve-thousand-ton loads. The enormously large fleets, now sometimes sent out, are an evolution of the erratic periods of navigation, economical for natural conditions, but not so for a regularly conducted business, as will be demonstrated below. Order and system will appear on the Ohio precisely as is now to be witnessed on the improved Rhine.

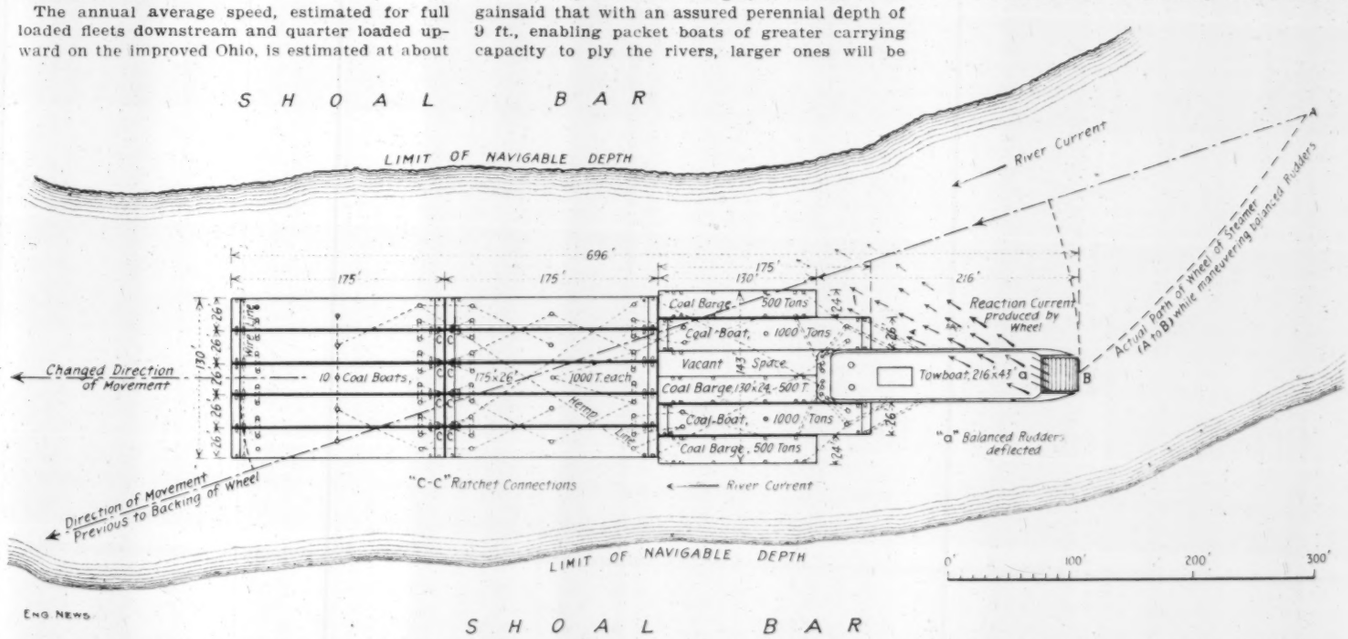
Cost of River Transportation.

During many years past a successful line of boats, carrying both freight and passengers, plied between Pittsburg and Cincinnati, and it has only recently ceased to be so profitable, owing, first, to the absolute refusal of the railroads to pro rate with river steamers; second, refusal of a large corporate steel company at Pittsburg to fill orders solicited by agents of the steamboat line, excepting when through railroad rates were included in the bills sent to the customers; third, want of sufficient warehouse boats and better roads from landings.

It certainly ought to be possible for buyers to route their goods in their own interests, but it seems this is not a universal privilege. While the writer believes that bulky freight for long distance transportation will, in the future, be most economically moved in barges, it is not to be gainsaid that with an assured perennial depth of 9 ft., enabling packet boats of greater carrying capacity to ply the rivers, larger ones will be built and operated. The naptha boats for local business between distributing centers, a system now in its infancy on some parts of the rivers, would also increase in number. Enterprises of this nature, since no great amount of capital is required, cannot fail to attract the attention of progressive individuals.

The expected advantages of the improved Ohio are not so much concerned, however, with the local traffic as with the interchange of traffic between states of the union, now commercially remote from each other. Down from the valley will pass iron and steel products, glass, pottery, brick, oil, lime, etc.; and upward from the south, timber, grain, including rice, cotton, baled hay, sugar, pork, tobacco, fluorspar, etc.

Data were secured in the U. S. Engineer Office, Pittsburg, several years ago relative to the size, power, equipment cost, and maintenance charge, in perpetuity, of a fleet of steamers and barges, the property of a manufacturing firm on the Monongahela River, doing a regular business of 8,000 tons of coal daily, winter and summer alike. In the case referred to, round trips of 52 miles or 104 miles daily were made by the fleets, including the passage of three locks in each direction. Later similar information was obtained covering several types of Ohio and Mississippi river towboats and barges. From the assembled data, careful estimates were made of the cost of handling 3,500,000 tons annually on the improved rivers from Pittsburg to Louisville, and from Louisville to New Orleans. It was found that 24.1 cents per ton would cover all costs, including insurance, depreciation of plant, etc., on coal, Pittsburg to Louisville, including return of empty boats to Pittsburg, a round trip distance of 1,200 miles. From Louisville to New Orleans and return of empty or partially loaded fleets to Louisville, on the same basis as for the upper Ohio, the estimated cost was 53.38 cents per ton, the round trip distance being approximately 2,720 miles. Such low rates could, of course, only be afforded on a large and regular traffic. There is reason to think, however, that miscellaneous cargo barges would, on the improved river, be more frequently mixed with coal boats than in former years, for already are seen many covered barges of steel rails, wire, nails, pipe for the Texas oil fields, structural steel for bridges, etc. Rates on such items will not be greatly in excess of coal rates, excepting, of course, insurance risks for greater valuation.



SKETCH OF SMALL FLEET OF COAL BARGES IN THE OHIO RIVER, SHOWING LINES BINDING THE FLEET TOGETHER AND TO THE PUSHING STEAMER, AND ILLUSTRATING EFFECT OF BALANCED RUDDER AND STERN WHEEL IN A CONFINED CHANNEL IN CHANGING THE DIRECTION OF THE MOVING FLEET.

Nine Feet Depth.

The radical improvement of the Ohio was started in 1884 upon the completion of the first of the series of Chanoine wicket dams near Pittsburg by Colonel Wm. E. Merrill, Corps of Engineers, U. S. A. The lock

SUMMARY STATEMENT. COST OF TRANSPORTATION.

(On basis of 2,000,000 tons on the Monongahela and 3,500,000 tons per annum on the Ohio, etc.)

Towing in fleets of barges.	Miles.	Average tons in fleets.	Average cost per ton, cents.	Cost per ton per mile, cents.	Capital invested.	Annual operating expenses.	Remarks.
Monongahela River:							
*Coal mines to Pittsburg	52	2,500	9.4	.18	$526,000	$83,946.50	Empty barges returned to mines.
Ohio River:							
Pittsburg to Louisville; river improved to 9 ft. depth	600	12,500	24.1	.04	2,080,000	845,000.00	Empty barges returned to Pittsburg.
Pittsburg to Louisville; present freshet system	600	15,000-25,000	45.8	.076	5,000,000	1,604,800.00	Empty barges returned to Pittsburg.
Ohio and Mississippi Rivers:							
Louisville to New Orleans; river improved to 9 ft. depth.	1,360	25,000	53.38	.039	3,480,000	1,868,632.50	Empty barges returned to Louisville.
Pittsburg to New Orleans on improved 9 ft. depth	2,000	.....	77.48	.039	.....	.....	Empty barges returned to Pittsburg.
Pittsburg to New Orleans; present freshet system	2,000	.....	135.00	.0675	.....	.....	Not returning empty boats but including their value in cost of transportation.

*With project for Lock 4, 41 miles above Pittsburg, completed, the minimum depth will be increased 3 ft. and lockage area more than doubled, which will result in considerable reduction of ton-mile rate from the coal fields to the head of the Ohio.

The new locks on the Monongahela have available areas of 360 × 56 ft. On the Ohio the locks are 600 × 110 ft.

chamber was 600 ft. long and 110 ft. wide, with a 6-ft. depth on the sills, carrying out the ideas of the early engineers who planned for the interest of the packet steamers, not foreseeing the possibilities of the towing system. In fact, there was a distinct hostility on the part of many of the towboatmen to any kind of locks and dams on the Ohio. It was inconceivable to them that any system of improvement could lower the cost of transportation below that conducted during freshets in the open river. As time progressed, however, and from much bitter experience waiting for expected rises, mines closed and fleets along the river stranded high and dry under the scorching rays of the sun, warping the hulls and opening their seams, the attitude of the rivermen changed. Having only 79 days annually, on the average, available for shipments from Pittsburg, and for other reasons too numerous to mention, it was found that from three to four millions of tons per annum was about the limit of the possibilities of the trade down the Ohio. Unbounded credit is due the Pittsburg rivermen for doing even that amount of business, accompanied as it is by so many risks and great annual losses, which in the aggregate, to date, have amounted to millions of dollars.

All the time, however, the demand for coal in the middle Ohio and Mississippi regions has continued to grow, which demand had of necessity to be supplied by the railroads, while coal-boats of 7 and 8-ft. draft were lying idle in the Pittsburg harbor. Time after time these men lost their control of the markets and as frequently regained it owing to their abiding faith in the rainstorms and in the river which responded to the storms.

To Col. Wm. L. Sibert, of the Engineer Corps, who was in charge of the upper Ohio locks in 1904-1906, is due most of the credit for convincing the Department officials that a very serious mistake was being made in the plans of the Ohio River locks. He was able to show that with three and one-half millions tons annual business, Pittsburg to Louisville, a 9-ft. depth would effect an annual saving of $550,000 to shippers over the 6-ft. depth.

The writer, in his younger days of vivid impressions, in charge of a United States survey steamer between Pittsburg and Cairo, has seen the great coal fleets in motion along various parts of the river. He has also seen them aground and has directed the removal of many of the wrecks which formerly, before the days of reliable steering, bestrewed their pathway to the Gulf, and long ago reached the conclusion that a 9-ft. depth, considering the warped bar surfaces over which they must in many places pass with scant margin beneath the boats, was the best. In elucidation of his ideas on this topic the following excerpt from a paper prepared for the Engineers' Society of Western Pennsylvania, May, 1908, may be of some interest in this place:

> Thus 50,000 tons of freight moving in a given direction can be considerably checked in its motion in the course of a few minutes and turned, if needs be, 30 or 40 degrees in another direction. This control of the direction of motion, which is an absolute necessity for fleets on rivers of comparatively shallow depth, is not practicable unless there is a margin of depth beneath the boats where side currents may expend their energies. A great fleet, a thousand feet long, hugging the bottom closely is about the same thing as a dike, and unless the side pressure exerted against such a moving fleet, developed by the currents, can find at least considerable relief beneath the boats, safe steering is impossible. Therefore, for increase of traffic in the future, we need not look to greater draft for the vessels.

Ohio River Dams.

Occasionally it is said that it might be advantageous to have some of the dams proposed for the Ohio made fixed structures with low adjustable tops so as to preserve a navigable depth at all times, where loaded fleets might lie in safety and more especially at important landings, or in front of transfer hoists or warehouse floats.

It is fortunate, indeed, that the plan of Chanoine dams calls for foundations admirably adapted for building upon them fixed structures at a moderate cost. There is nothing alarming, therefore, in the proposition that future needs may require the partial conversion of some or all of the completed dams. And it is equally fortunate that this great project, so well worthy of the nation's fostering care, is in nowise distracted with any rival plans worthy of consideration.

The surveys conducted during the past season by Captain Lytle Brown, under the direction of the Ohio River Board (Colonel Wm. T. Rossell, Major H. C. Newcomer, and Captain F. W. Altstaetter), were specially directed to the determination of the precise location, character of foundations, and definite plans in all respects for the 16 dams above No. 30 for which no provision has hitherto been made.

It is supposable, therefore, that active work of construction will speedily follow the appropriation of the necessary funds.

Conclusion.

It cannot be conceived that the Central States, occupying the heart of the Mississippi Valley, with their wealth of developed industries and unrivaled natural resources are to become land locked provinces having no commercial water connections with the open sea, and their people left no intelligent voice on questions relating to the development of our foreign commerce. Surely, the great cities of the valley which have been reared in an opposite conception will not much longer ignore the possibilities of improvement of the great arteries which sustained their growth for so many decades.

Only with waterway outlets to the sea is there that sense of freedom in great communities which incites individual effort to the maximum. A pall necessarily hangs over enterprises where transportation rates are determined by cliques of traffic managers. Railways in their inception were to be common roads with tolls to be charged to whosoever operated cars on them, but the limitations of the service prevented the carrying out of such arrangements. On the rivers, however, the case is different, for they are free to all the people. Combinations may seek to control the traffic and fix the freight rates, but as individuals can, with independent boats, defeat unjust schemes, the rivers promise for all time to be public property, navigated by the public for the benefit of the public.

Traffic on the Ohio River.*

By JOHN HOWE PEYTON,† M. Am. Soc. C. E.

"No subject of the national policy has been more distorted by partial views, more disfigured by misapprehension, or more dwarfed by the conflict of local interests than the governmental work of improving our harbors and waterways."—Senator P. C. Knox, of Pennsylvania.

Many of our "statesmen" and writers, including such men as Secretary Knox, argue that, since a considerable down-stream traffic has been found possible on the Ohio River, during a few months of each year, we should proceed to spend immense sums on the Mississippi, Missouri, Ohio and other rivers.

Some facts about commerce on the Ohio River will make apparent the absurdity of comparing it with the Mississippi, and, incidentally, show the exceedingly questionable wisdom of expending many millions of dollars on a scheme for its canalization.

There are immense deposits of valuable coal in portions of the great basin drained by the Ohio River. Along certain of its tributaries—the Monongahela, Allegheny and Kanawha Rivers, in the States of Pennsylvania and West Virginia, coal is mined from a small portion of these deposits, and dumped directly from the mine cars, over tipples into barges moored to the river bank. These barges may be lashed together in great fleets, carrying from 10,000 to 60,000 tons of coal, and floated down the river, during stages of high water, with no expense for motive power, except that of a tow-boat to guide the fleet.

These remarkably favorable local conditions have made it possible to transport coal, at low cost, by water, from mines that are so situated that their output may be dumped directly from mining cars into barges, which, when guided by a steamboat, will float to the cities and manufacturing plants situated immediately on the banks of the lower waters of these streams and of the Mississippi River.

But only a very small per cent. of the coal mines in Pennsylvania and West Virginia are so situated that their owners can take advantage of this possibility. In the year 1907, there were 1,425 coal mining operations in the State of Pennsylvania, of which number only 39 shipped their whole product by river, and only 13 others use the river at all for shipping, while 1,357 mines shipped their whole output by rail.

River shipments from Pennsylvania are made only from mines on the Monongahela River and a small portion of the Allegheny River. Only a portion of even this narrow strip, immediately adjacent to the river bank, is being made tributary to the river trade. Many of the mine operations, even in this narrow territory, prefer to ship by rail, so that their product may be delivered, over spurs and sidings and inclines, directly to furnaces and factories, instead of being lifted from barges in the river and trans-shipped, even a few hundred yards. Most of the managers of the big furnaces and factories, located on the banks of the river, prefer to receive their coal and coke by rail.

All efforts to utilize the river for shipment of coal from properties that are not close to its banks have failed, except in two or three instances where remarkable local conditions exist, or where coal operators were able to force very low rates and favorable terms from railroads extending from their mines to the banks of the river.

An insurmountable difficulty that must prevent any benefit accruing to the citizens of the nation from an increase in the area of the territory from which it is practicable to ship coal by water is found in the immense cost of the plant required for such shipments. So costly is such a plant that only big corporations can afford the outlay. If a small operator on the river front should think of utilizing the water for shipping, he would find the following difficulties to be overcome:

The best coal barges cost from $2,000 to $3,000 each. An effective steam tow-boat costs $120,000. The average speed of movement of coal fleets, on the river, is about five miles per hour (seven miles down stream and three miles up stream). All the cities along the Monongahela, Allegheny, Kanawha, and Ohio Rivers, from their upper waters to the Kentucky state line, are in the vicinity of rich coal territory with markets fully supplied, so that Cincinnati and Louisville and lower cities are the nearest available river markets. Even in the last-named markets, the river coal must compete with coal brought in by railroad lines which are steadily reducing their freight rates as they reduce their grades and improve their roadbeds and rolling stock.

The small operator finds, then, that he must ship his coal at least as far as Cincinnati (over 500 miles from Monongahela and Allegheny River territory); that, with a movement of only five miles per hour his towboats will, on account of unavoidable delays, average only about 100 miles per day during the navigable season, and make a round trip in ten days; that the barges will not ordinarily be emptied and returned within six months, and may be gone ten or twelve months. Under such conditions he must provide at least two towboats, at a cost of $240,000, and probably 100 or more barges, at a cost of $200,000 to $300,000, all of which plant will deteriorate rapidly. Manifestly such expenditures cannot be made profitable except when immense shipments are being made. The small mine operator can usually arrange with some near-by railway for a cheap spur track, that will place cars directly under his mine tipple, into which he can dump his coal. The railroad supplies the necessary cars and locomotives and delivers the coal at the precise spot at which it is wanted, by the furnace or factory, in a fraction of the time required for water shipment. Manifestly, the water shipment is impracticable except for the big monopoly. Hence we find that the Monongahela River Consolidated Coal & Coke Co. has monopolized about 75% of the traffic on the Ohio River between the mouth of the Great Kanawha River and Pittsburg.

Mr. William Jennings Bryan said in an address before the recent "Deep Waterways Convention" in Chicago:

> "The railroad cannot rival the water course in cheapness, and there is another advantage that the water course has. When you furnish a river sufficiently deep for commerce, or a canal upon which boats can float, you make it possible for a man with small capital to act. * * * Where there is a river, any man who can build a boat can engage in transportation, and if he cannot build a big boat, he can build a little boat, and if you have a large number of little boats, the big boats will have to meet the rates that the little boats fix."

It would be difficult to compress into so small a space a larger amount of nonsense. The company that has, so far, made a success of Ohio River traffic and monopolized about three-fourths of it, had, in October, 1908, at Pittsburg, 1,100 coal barges loaded with coal; between Pittsburg and Parkersburg, 2,300 barges; 75 steamboats and barges empty or loaded, scattered along the Ohio and Mississippi Rivers from Pittsburg to New Orleans, representing a total capital investment of $6,826,000.*

Under existing conditions, only 52 mines out of 1,425 in the State of Pennsylvania now ship by river. These few operations are confined to narrow strips of terri-

*Extracts from Chapter XII. of Mr. Peyton's book on "The American Transportation Problem." The complete book, a volume of 326 pp., is published by and can be obtained from the "Courier-Journal," Louisville, Ky., price 50 cts.

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*See statement of George W. Theiss, President of the Monongahela River Consolidated Coal & Coke Co., made before the Ohio River Improvement Association at Louisville, on October 22, 1908.

tory along the banks of the Allegheny and Monongahela Rivers, from which many other mines ship by rail. Many of these river mines have been operated on a large scale for years. Evidently the territory must be exhausted within a very limited period.

In the State of West Virginia there are 785 coal mining operations in progress, and only 15 of them ship their product by river. In West Virginia only 38 miles of the canalized portion of the Monongahela River are in the coal field. Only 35 miles of the canalized portion of the Kanawha River are within the coal field. Within these narrow confines there are also many mines in operation that ship their product, wholly or in part, by rail.

The national government had expended, up to June 30, 1908, on the Monongahela River, $9,289,583; on the Kanawha River, $5,102,953; on the Allegheny River, $1,891,969. The coal operations within a portion of the narrow territories, above described, are almost the sole beneficiaries. There are no mines in Pennsylvania or West Virginia, and only a few small ones in Ohio immediately adjacent to the Ohio River, which ship by water. The tremendous expenditure proposed for its canalization would serve very little coal territory not now using the river, and would only further serve the little territory along the Kanawha, Allegheny and Monongahela Rivers. This might possibly be increased slightly by expending millions for the further canalization of a few miles of the Allegheny and Youghiogheny Rivers in Pennsylvania.

No further canalization of rivers within coal fields of West Virginia is practicable, though there is a scheme for eight locks and dams to give a 6-ft. depth in the Tug Fork of Big Sandy River; and no canalization within the coal fields of Kentucky or Tennessee is practicable, though the government is wasting large sums of money on the Kentucky and Big Sandy Rivers in an effort to give slack water with 6 ft. depth, reaching the edge of coal fields.

The Board of Engineers for Rivers and Harbors reported to the Chief of Engineers, on Oct. 18, 1907,* that the total traffic on the Ohio River is about 9,350,000 tons. About this the Board makes the following statement:

"A large portion of this commerce is coal. Of the freight reported as passing through the Davis Island Dam, 91% consists of this product; through the Louisville and Portland Canal and over the falls of the Ohio at Louisville, 92%."

About 75% of the entire shipment of freight on the Ohio River from Pennsylvania and the portion of the Monongahela River in West Virginia, belongs to the Monongahela River Consolidated Coal & Coke Co. Of the balance, 23% belongs to six other coal companies, and 2% to all other interests. The following tabulation shows the amount of each shipment in ton-miles:†

	Ton-miles.	
Monongahela River Consolidated Coal & Coke Co.	1,864,112,480	(75%)
Six other coal companies (includes all their shipments on the Ohio)..	559,931,388	(23%)
All other traffic	40,253,392	(2%)
Total traffic as above stated	2,463,297,260	(100%)

Cost of Monongahela River Transportation.

The traffic borne on the Monongahela River is far greater, in proportion to navigable length, than that on any other stream in the Mississippi basin. The total amount of freight handled in the year 1908, as computed from data supplied by the reports of the Chief of Engineers, was 465,696,994 ton-miles.

The total capital investment in the Monongahela improvement to June 30, 1908, was $6,947,152.

Interest on this investment at 4% is	$277,886
Annual cost of maintenance (average for 4 yrs.).	259,414
Total cost to the public for the year 1908 was	$537,300

This gives a ton-mile cost of .12 cts. paid by the people of the whole Nation. In addition to this, however, there is the cost of actually handling the tonnage by boat.

Capt. William L. Sibert, Corps of Engineers, U. S. A., who is a high authority on river transportation, and has made elaborate investigations, reports that the average cost per ton-mile for coal handled on the Monongahela River by "A certain large steel manufacturing and furnace company in Pittsburg" is .18 cts. per ton-mile. These manufacturers use over 2,000,000 tons of coal per annum and operate 180 barges and four steamboats. They own all their own plant and operate on a great scale, with everything thoroughly systematized, and on the most economical basis that is found possible. Yet the cost of handling coal is .18 cts. per ton-mile, making a total cost of 0.3 cts. per ton-mile. But "on the main lines of the various railway systems, freight is being transported in train-load lots at a rate of less than 0.20 cts. per ton-mile."‡

The Big Four Railroad is hauling coal in train-load lots at 0.186 cts. per ton-mile; only 62% of the cost of Monongahela River coal transportation. The Louisville & Nashville R. R. Co. is hauling coal across the rough mountain region, between Tennessee and Kentucky coal fields and Atlanta, Ga., for 0.265 cts. per ton-mile. The Norfolk & Western Ry. is hauling coal across the mountains to the seaboard at 0.331 cts. per ton-mile, and the Illinois Central R. R. is transporting coal from western Kentucky to New Orleans at a rate of 0.21 cts. per ton-mile.

It will be observed that the above river traffic figures are based on the cost of transporting coal by a big corporation, handling immense quantities, and using its own steamboats and barges. Such figures are wholly impossible for the ordinary shippers of freight, or for the man operating a small coal property. To such a one the cost would probably be twice as great, if, indeed, river shipments were at all practicable for him.

A further examination reveals the fact that there are 15 locks and dams in the Monongahela River, and that most of the tonnage originates below lock No. 5. For the upper ten locks we find the following figures: Total ton-miles in 1908, 4,826,869. Ten-fifteenths of total cost of Monongahela improvement = $4,631,435.

Interest on investment at 4%	$185,257
Annual cost of maintenance (aver. for 4 yrs.)	172,943
Total cost to the public	$358,200

This gives a cost of 7.42 cts. per ton-mile, and with the added cost of 0.18 cts. for handling by boat, we find a total cost of 7.60 cts. per ton-mile for this portion of the river traffic on the Monongahela for 1908—40 times as much as it costs to haul coal in train-load lots on the Chesapeake & Ohio and the Big Four R. R. from the coal fields to Cleveland, and 28 times as much as it costs on the Louisville & Nashville R. R. to haul the same class of tonnage, up and down hill, across the rough mountain country lying between Eastern Kentucky and Atlanta, Ga., along which route there is no competing waterways to "regulate rates."

Perhaps there is nowhere in America a more flagrant example of the "pork barrel" abuse in internal improvement than is the canalization of the upper Monongahela River. Costly locks and dams have been built that are practically useless and worthless obstructions in the river channel. During several months of last year, there was not enough water in the river to fill the pools above the dams, even when no lockages were required. The locks and dams in the Monongahela River, in West Virginia, are a subject of much merriment among the citizens of the region.

Kentucky River Transportation.

On this stream, on which $5,568,056 had been expended for construction, operation and care, previous to June 30, 1908, the report of the Chief of Engineers makes the following laconic remark:*

"The principal commerce on the river is timber, much of it loose logs, and the improvement is rather detrimental to this than otherwise. The logs are damaged in passing the dams, and in turn cause much damage to the works," and "it is believed that the project has had so far no material effect on freight rates."

The total traffic on this river in 1907 was 209,893 tons. The capital invested in permanent improvement is $3,931,850.

Interest on investment at 4%	$157,274
Annual cost of maintenance (aver. for 4 yrs.)	122,591
Total cost to the Nation per annum	$279,865

In this case the ton-mileage is 26,467,459, and the cost per ton-mile is 0.93 cts. Here there is no competing railroad. The boat charges consequently are higher than average railroad charges, and the total ton-mile cost for all commodities is far higher than the railroad charges on similar commodities.

It is interesting to note that the $5,558,056, with accrued interest, would probably have built an ordinary second-class railroad, extending from the mouth of the river to the head of the system of locks and dams, over which the $279,865 of annual cost to the people, would pay freight at the average rail rate of 0.76 cts. on the 209,893 tons for 126 miles distance (that was the average length of shipments on the Kentucky River for 1906), saved to the "dear people" what they paid the boats for freight charges, left a balance of $78,872.69, and also left the stream clear of dams that now obstruct the channel and interfere with the "principal commerce on the river, which is floating timber—mostly loose logs." Such a railroad would have given a stimulus to development along its route that would have increased the value of property by many millions of dollars, and could have been leased or sold for a great sum. No rational man would accept the locks and dams as a present, if required to operate and maintain them.

Perhaps the most astonishing feature of the whole mad scheme for improvements of inland waterways is the showing made by an analysis of conditions affecting traffic on the Ohio River, which all the agitators name as par excellence, the river which should be improved and the one which they hold up as an object lesson to justify their schemes for spending vast sums (to be obtained by bond issue) on this and other streams.

The special "Report of Examinations of Ohio River" submitted by the Chief of Engineers on Jan. 10, 1908,* shows the following expenditures and estimates of cost:

Expended on lock and dam project, prior to March 2, 1907	$9,281,376
Estimate to complete, subsequent to March 2, 1907	63,731,488
Expended on Louisville & Portland Canal	3,960,258
Estimate to enlarge Louisville & Portland Canal	1,760,000
Total estimated cost of 9-ft. project	$78,679,122

This does not include $6,696,333, hitherto expended on general improvement.

The system will consist of 54 locks and dams.

The reports of the Chief of Engineers show that the cost of operations and care for one year, of the three locks (Nos. 1, 2 and 6) that were in service in 1907, was $56,027, or an average of $18,675 for each of the plants.

The three dams mentioned are away up towards the head of the river where the stream is comparatively narrow. It would seem certain that the cost where the river is two or three times as wide, must be much greater, but, having no data on which to base an estimate, we will assume $18,675 as the average annual cost of operation and maintenance for each of the 54 dams.

The report of the Chief Engineers gives the average cost of operation and care for the Louisville & Portland Canal for 1906, 1907, and 1908, as $106,496. Certainly this figure will not be any smaller with a larger canal and higher dams.

The report states that it was necessary to remove by dredging 224,399 cu. yds. of mud from the canal, during the year 1906. This being the case, what are we to expect when the locks and dams are greatly enlarged? What are we to expect as to the ten locks and dams to be placed below Louisville, in the portion of the river, much of which resembles the Mississippi, in that it carries an immense load of silt rolling along the bottom of its bed? The Board of Review raised the original estimate of cost of operation and care by $200,000, on account of this condition, which is to be faced in the lower Ohio. The estimate seems wholly insufficent, but because of lack of definite knowledge, we will use the same figures for probable cost of dredging—we have therefore the following:

Interest charge of 4% per annum on $78,679,122.	$3,147,164
Operation and care of 54 locks, etc., at $18,675 per annum	1,008,494
Annual operation and care, Louisville & Portland Canal	106,496
Annual cost dredging in locks and above dams.	200,000
Total annual charge against traffic	$4,462,153

The special report of the Chief of Engineers, above referred to, gives commercial statistics for the Ohio, showing an aggregate tonnage of 13,165,656 tons for the year 1905. (One year later the total traffic is stated at 11,427,784 tons—for 1908 the showing will probably be much smaller.) It is explained, however, that this is far too high because it includes a great deal of duplication—the same tonnage being included in statements from two or more points. After a thorough consideration of the available data the Board of Review reached the conclusion that the actual total weight of freight was probably 9,350,000 tons. The report gives the distance that this tonnage was carried.

Computing the ton-mileage on this basis, we find that the total, for the whole river, for the year 1905 (the date on which the Board of Review based their statements), was 2,735,017,317, and this divided by the total tons carried gives an average distance of 292.52 miles. The total for the 12 months since the panic of October, 1907, will be far less.

Major Sibert, of the Corps of Engineers, a distinguished engineer and a recognized authority on such matters, has made elaborate investigations and computations of the cost of moving coal on the Ohio River. The results of his investigations have been published in pamphlet form, and show that the cost of shipping coal in large quantities, on the unimproved river, from Pittsburg to Louisville (598 miles) is 45.8 cts. per ton, or 0.076 cts. per ton-mile. The cost below Louisville is slightly lower, but since we have no authoritative data on which to base a calculation, we will assume that the cost from Pittsburg to Cairo is 0.076 cts. per ton-mile, which gives a total of 73.3 cts. as the cost per ton between Pittsburg and Cairo (965 miles).

Other elaborate computations, made by Major Sibert, show that the cost of similar river traffic between Pittsburg and Louisville, with the improvement completed so as to give a continuous 9-ft. stage will be 24.1 cts. per ton, or 0.04 cts. per ton-mile.

Major Sibert further shows that, on a 9-ft. permanent stage, coal may be shipped from Louisville to New Orleans for 0.039 cts. per ton-mile, and this rate for the 367 miles between Louisville and Cairo would give a cost per ton of 14.3 cts.—giving a total cost of 38.4 cts. from Pittsburg to Cairo. This shows a saving of 34.9

*See House Document No. 492, 60th Congress, 1st Session, pages 111-15.

†From pages 1667 to 1670 of the Report of the Chief of Engineers for the year 1907.

‡See report of the Board of Engineers for Rivers and Harbors, House Document No. 492, 60th Congress, 1st session.

*See page 610 of "Report of the Chief of Engineers" for 1908.

*See House Document No. 492, 60th Congress, 1st session.

cts. per ton on coal shipments when made in quantities of 3,500,000 tons per annum—the shipper owning and operating the entire necessary plant—and when shipped a distance of 965 miles without breaking bulk. The rate, under such conditions, for the whole river, unimproved, is 0.076 cts. per ton-mile, and for the river improved to a 9-ft. stage will be slightly less than 0.04 cts. per ton-mile. The cost then for the whole 2,735,017,317 ton-miles of the traffic of 1905, on the unimproved river, if handled by one company, would have been $2,078,613, and with the river improved to a 9-ft. slack-water stage, the cost for the same tonnage will be $1,094,006, a saving of $984,606. The cost to the people of the Nation, per annum, of accomplishing this saving will be $4,462,155.

Verily, great is the waterways agitator in the role of political economist!

The total traffic of the Monongahela River Consolidated Coal & Coke Co., on the Ohio River, for the year 1905, was 1,914,418,887 ton-miles or 70% of the whole traffic on the river. The proposed generous expenditure of the money of the people of the nation would save for that great monopoly $689,224 per annum, and $3,121,509 would be the cost to the people of accomplishing that saving for the coal monopoly, which sells coal to citizens along the river at precisely the same prices at which the same quality of coal is sold when hauled by the railroads.

The result will be of practically no benefit to the people, since the coal corporations will, of course, continue, as in the past, to sell coal at the highest price that is possible while continuing to hold the markets against the railroads.

The monstrous absurdity of all this is still more strongly emphasized when we realize that the coal territory, from which these corporations draw their supply must be exhausted in a very limited period, and that until it is exhausted, the people of the nation are assisting a few Pennsylvania and West Virginia coal corporations in an effort to exclude the owners and operators of coal territory in the vast fields of Ohio, Indiana, Kentucky, Tennessee, and Alabama from obtaining a reasonable profit in their home markets. An opposite policy would, of course, build up the coal shipping business of those states; give employment to great numbers of home people; increase taxable values and stimulate general business; thereby helping the merchants and manufacturers of the river cities by creating a home territory demand for their goods.

But for the firm stand taken by the Speaker of the House of Representatives, we should probably have had a bill passed last winter committing the Nation to the prosecution of schemes more preposterous than any of those advocated by the charlatans and rascals who promoted the "Mississippi" and "South Sea" bubbles 200 years ago.

That there is no hope for an increase of traffic in the future is evident since—

First. The packet boats will certainly be forced out of business as additional railroads are built closely paralleling the river.

Second. The coal territory, which will make a large traffic possible for a while, must be exhausted within a very limited period. The reduction of the supply and the increased consumption, for coke and other uses, in the Pittsburg district, will probably sharply reduce the river shipments from the territory above that city within a decade—long before the canalization of Ohio River can be completed.

Third. The Engineers of the Board of Review state, "It is believed that as much coal is now shipped by water as there is a demand for on the lower rivers." The present demand for "river coal" will probably be sharply reduced when the railroads have completed certain radical improvements that will enable them to haul coal from Western Kentucky, Illinois, and Alabama to New Orleans and other river cities, at greatly reduced cost. It is probable that the railroads will be able to place Alabama coal at the doors of New Orleans factories at a cost, for transportation, of less than half the cost of the transportation by water from Pennsylvania and West Virginia, even though all Government expenditures be omitted from the reckoning. The Illinois Central R. R. is now hauling coal from Illinois and Western Kentucky to Memphis at such low cost that the "river coal," from Pennsylvania, has been almost forced out of that market. Anderson's report for the year 1907 showed that 591,000 tons of coal were brought into Memphis by rail, and only 50,000 tons by river.

Fourth. As the railroads reduce their grades, eliminate curvature, improve their roadways with ballast and heavier rails, and install more powerful locomotives and cars of greater capacity, they will be able to deliver coal from the coal fields near the river cities, to those markets cheaper than the boats can bring it the longer distance, in spite of the Government favoritism towards the water route.

Coal is now shipped over the Chesapeake & Ohio R. R. from the Kanawha coal fields via Cincinnati (236 miles) to Cleveland at a rate of 0.185 cts. per ton-mile, or a total cost of 44 cts. per ton. The distance from the Kanawha coal field to Cincinnati by the water route is 277 miles. The cost on the canalized Kanawha is 0.54 cts. per ton-mile (73 miles) and on the Ohio, when canalized, the cost will be 0.20 cts. per ton-mile (204 miles). The total cost, therefore, by water will be 80.22 cts. per ton, while by rail it is 44 cts.

Since, however, the people of the Nation at large will, when the Ohio River improvement is completed, assist the corporations that ship by water to the extent of 51.6 cts. per ton, and leave them to bear only 28.62 cts. per ton of the cost of transportation (though they contribute to the support of the Government nothing that is analagous to the immense sums that the railroads pay in taxes on their roadbed, right-of-way, terminals, etc.) the rail route may not be able always to compete successfully with the water route. Nevertheless, so great are the inconveniences, dangers, and delays of water transportation, and so poor are the facilities provided by the boats for delivering their freight, that in spite of the fact that the people of the nation even now, while this portion of the Ohio River is unimproved, are paying over half as much to assist the water shipments between the Kanawha coal fields and Cincinnati, as the total cost of rail shipment between the same points (and will eventually actually pay more than the total railroad cost between the same points), yet the rail line does still transport immense quantities of coal from the Kanawha fields to Cincinnati at rates much higher than its through (Cleveland) rates, above mentioned. It is highly probable that the railroads will always handle a large portion of this tonnage, in spite of the preposterous Government favoritism exhibted towards water routes, because the rail line is certain and swift, and can deliver the coal at the precise point at which it is needed.

Coal is now shipped over the Illinois Central R. R. from Western Kentucky to New Orleans (712 miles) for $1.50 per ton, or at 0.21 cts. per ton-mile.

At New Orleans this coal comes into competition with the "river" coal (belonging to the Pittsburg trust) which has been floated down the Monongahela (64 miles), Ohio (965 miles), and the Mississippi (966 miles); a total distance of 1,995 miles. The cost of moving a ton of coal along one-half of the length of the improved portion of the Monongahela River is 19.20 cts., of which the people of the Nation pay 7.68 cts., and the coal monopoly pays 11.52 cts. The cost of moving a ton of coal along the Ohio River, when improved to 9 ft. depth will be $1.93, of which the people of the Nation at large will pay $1.55 and the coal trust 38 cts.

The cost, to the people of the Nation of moving coal down the Mississippi River from Cairo to New Orleans cannot be stated with certainty. We know, however, that the total commerce on this portion of the Mississippi River in 1906 was 1,556,420,117 ton-miles, of which 853,291,070 ton-miles was coal and coke from the Ohio River—almost all of it being the property of the Pittsburg trust. We know also that the National Government is now expending or attempting to expend $2,000,000 per annum in addition to ordinary appropriations, on the "improvement" of the Mississippi River below Cairo—the "improvement" for navigation being the maintenance of a 9-ft. channel by means of hydraulic dredges, and that the usual explanation and apology for this work are that the tonnage of coal and coke from the Ohio River, borne in barges requiring a 9 ft. depth, justifies the cost of maintaining a 9-ft. channel.

The cost, to the coal trust, for moving a ton of coal from the Monongahela field, via the rivers, to New Orleans (1,995 miles), will be 93.1 cts. In addition to this there will be a cost to the people of the Nation of $1.63 per ton for the portion of the distance that extends from the coal fields to Cairo. Furthermore, there is a cost now paid by the people, of $2,000,000 per annum in addition to ordinary appropriations for improving the Mississippi below Cairo, where 55% of the whole commerce belongs to the same coal trust [55% of $2,000,000 is $1,100,000, but we cannot use this figure because a portion of the Mississippi River appropriations are expended on levee construction]. It will, therefore, cost the people of the Nation 13 cts. more, per ton, to assist the coal trust in transporting coal from Pennsylvania to Cairo, en route to the lower Mississippi ports, than the Illinois Central R. R. charges for transporting coal 712 miles, from Western Kentucky to New Orleans, and the Government is spending immense additional sums to further assist the monopoly in forwarding this same coal on down the Mississippi River to New Orleans.

The ridiculous nature of the scheme is still further emphasized when we remember that coal is now being shipped from the Alabama fields to New Orleans (418 miles), via the Louisville & Nashville R. R., for $1.25 per ton, and "run-of-mine" coal, in carload lots, is actually being sold in New Orleans at $2.75 per ton. This is less than the sum the "statesmen," including our strenuous ex-President, wish to have the people of the Nation contribute towards assisting the Pittsburg monopoly in transporting coal from the limited Pennsylvania coal field, to New Orleans.

We have seen that our statesmen propose to tax the people of the Nation to the extent of $1.63 per ton, in order to assist the monopoly in transporting coal from Pennsylvania as far as Cairo. It is astounding to find that coal (run of mine) from the Illinois field is actually now sold outright, in Cairo at $1.45 per ton. The "statesmen" propose also to assist the monopoly, with money collected from the people, in further transporting this same coal to Memphis (probably at about 50 cts. additional cost per ton). Coal from the Illinois coal fields is now sold in Memphis, in carload lots, at $1.90 per ton. It were far less costly for the Government to buy the coal from the Alabama, Illinois, and Western Kentucky fields, *give it outright* to the people in Cairo, Memphis, Vicksburg, Natchez, and New Orleans, and pension the members of the Pittsburg coal trust.

We find, then, that the proposed expenditure on the Ohio River improvement means a tax on the people of the whole Nation, in order to assist a Pennsylvania monopoly in "carrying coal to New Castle"; when there are already vast quantities of coal in that territory that may be purchased outright at a cost smaller than the sum that the "statesmen" propose to have the people contribute towards the cost of transportation from Pennsylvania.

The folly of the proposed expenditure of $63,731,488 on the Ohio River, in addition to the great sums already expended, is still further emphasized by the fact that the managers and owners of the pampered Pennsylvania and West Virginia coal industries assert that they would rather have the river as it is, than have fixed dams erected that would prevent their floating their product to market on the open river, during the smaller rises.

The dams being erected, are movable and are thrown down when not needed to give a 9-ft. stage of water. It is seen then that the result of this vast expenditure will not be utilized, during flood periods, since the loaded coal vessels are most economically handled if floated down stream, in high water, when locks and dams are not needed, and probably 75% of the coal that will be shipped down the Ohio will go on the river when it is at high stage, and will not utilize the locks and dams. The locks and dams will, of course, enable the coal vessels to move at all seasons and will afford deep and still water, to facilitate the return of empty barges, but 4 or 5 ft. of water would be sufficient for the empty barges and for the Ohio River packet boats.

It seems certain that when the limited coal area in Pennsylvania and West Virginia, now tributary to river transportation, on the Ohio, is exhausted, the locks and dams that shall have been constructed will be practically useless, and not worth maintaining; and that the whole Ohio River canalization improvement will be but another monument to the folly of men who allow themselves to be governed by prejudice, or misled and duped by demagogues and political agitators.

The locks and dams along the James River in Virginia were long since abandoned, and similar works, on which immense sums of money have been wasted, have been abandoned in other parts of the country. A large share of the state debt of Virginia, under which she has been groaning for half a century, was incurred in building the old James River and Kanawha Canal.

Lake Erie and Ohio River Canal.

The waterways agitators are trying to lead the public to believe that there is some likelihood of water transportation between the Great Lakes, which are navigated by vessels drawing 20 ft., and the Gulf of Mexico, which is navigated by vessels drawing 20 to 30 ft., by way of a 12-ft. canal (estimated to cost about $30,000,000) from Lake Erie to Beaver on the Ohio River, thence down the 9-ft. (proposed) Ohio to the Mississippi, and thence down the 14-ft. (proposed) Mississippi to New Orleans, and thence to foreign ports in vessels drawing from 20 to 30 ft. of water.

This would necessitate breaking bulk and transferring freight four times, if transfer be made from boat to boat, or eight times if transfer be made from boat to wharf and then to another boat, besides encountering all the difficulties and dangers of the Ohio and Mississippi Rivers for 2,000 miles after a canal trip of about 100 miles, from Lake Erie to the Ohio River at Beaver.

It might be amusing to speculate as to how many-fold more costly this would be than rail transportation (the Illinois Central R. R. is only 923 miles long from Chicago to New Orleans) were there any likelihood of a single ton of freight ever making the 2,100 mile journey with freight transferred four to eight times, when the rail distance, via Pittsburg to New Orleans, is only 1,212 miles. But it is useless to entertain this "iridescent dream" because there are difficulties about building the "Lake Erie and Ohio River Canal." For instance: There is a high summit between the lake and the river, with practically no water available. If a canal should be built with timber gates to the locks they would be in danger of destruction by fire caused by sparks from passing railroad locomotives!

THE FREIGHT-CAR SITUATION has been practically stationary for a month or more past. The last statement of the American Railway Association's committee, for Feb. 2, shows a surplus of 51,600 cars, about the same as the figure for Sept. 29, 1909. There are still shortages in various sections, aggregating about 26,000 cars, indicating that the car movement is not yet fully regular. Reports from the Middle West are that the blockades due to snow some weeks ago are fairly well cleared up.

The Design of the Stations on the Evanston Track Elevation Work; C., M. & St. P. Ry.*

By E. O. GREIFENHAGEN.†

On the track elevation work of the Chicago, Milwaukee & St. Paul Ry. at Evanston, Ill. (north of Chicago), there are four passenger stations about ½-mile apart. Platforms at the sides of the tracks were adopted in preference to island platforms, for reasons stated in a former article describing the track elevation work. The platforms are 225 ft. to 240 ft. long, accommodating six-car trains. It was required that they should be located on tangents, and that the stairs leading to them should be placed as near as possible to the middle of the platform.

The location of the building with respect to the streets was the second important factor. It was governed by the location of the platforms and by the requirement that the latter be middle-loading rather than end-loading. The first idea for three of the stations was to have the building directly underneath the tracks and facing the intersecting street. Stairways were to lead from the building to the middle of the two platforms. This would have made it necessary to extend the platforms over the intersecting street on the subway bridge, which was objectionable from an aesthetic standpoint. Unfortunately there was a jog in the right-of-way at each of the streets at which the stations were to be located, which required heavy curves over Davis and Main Sts., and which would not permit both the station platforms and the future track over Dempster St.

The reasons for restricting platforms to tangents will be seen from the following statement. On tangent track it has been the practice to locate the edge of the station platforms (level with the car floors) about 3 ins. from the clearance line of the car, leaving a space of only 3 ins. for passengers to cross. On a curved track, however, the middle of the car encroaches on the clearance line and makes it necessary to set back the convex platform beyond this line by an amount depending on the distance between centers of trucks and the degree of curvature. The ends of the car move away from the platform edge and further increase the opening and, as a result, a considerable gap is left between the edge of the platform and threshold of the car. This gap is dangerous, and is likely to cause expensive accidents.

Since the platforms could not be brought over the subways, the only remaining scheme which would keep the station buildings on the intersecting street, was that which involved end-loading platforms. Platforms which are end-loading are decidedly undesirable from an operating standpoint, because they tend to become congested at the end near the head of the stairs, through the inclination of crowds to hesitate about moving forward of their own accord. Passengers crowded at one end of the platform when the train pulls in, will all try to file through the nearest car doors and thus greatly increase the length of the stop. To obviate this difficulty, and to bring the stairways near the middle of the platforms, it was decided to locate the buildings between intersecting streets. Such an arrangement worked out very well on account of the location of north and south streets paralleling and adjoining the right-of-way.

The general features of the layout are shown in Fig. 1, which is a plan of the Davis St. station. The entrance faces Benson Ave., which runs parallel to the tracks. All of the station layouts are special; they depend on the width of the right-of-way and the location of the tracks. The general arrangement of the Davis St. station is typical, however, and will serve to illustrate the conditions.

The building is set about 4 ft. from the inner edge of an 8-ft. sidewalk on the company's property. Passengers pass through the building, out of a side door on either side and up a front stairway to the east platform or through the rear doors and the subway to the back stairs and west platform. Incoming passengers leave the west platform through the subway and through the building, or through the subway and around the 6-ft. passages to the exterior exit turnstiles. Passengers from the east platform find an exit through the turnstiles near the foot of the east stairs.

The Dempster St. station is very similar, but the building is set further forward and there are no side exit doors. All stairways are reached through the rear door. Exit from all stairways may be made through either the interior exit passages or through the outside exit turnstiles. At Main St. the station building is set even farther forward than at Dempster St., but the scheme of circulation is no different. Fig. 2 is a section of the Main St. station taken along the center line of the building.

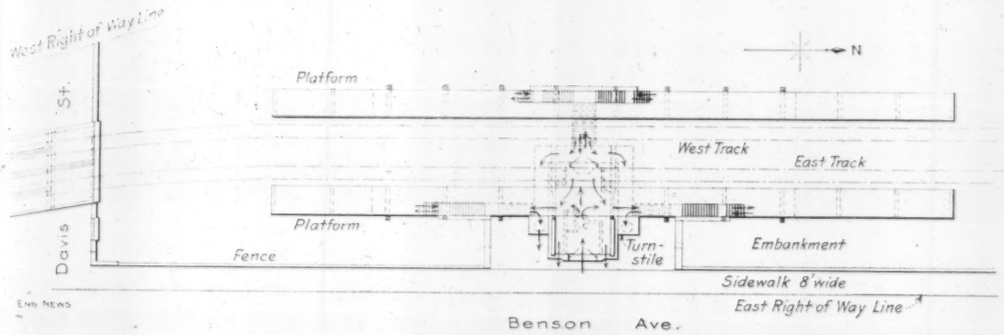


FIG. 1. PLAN SHOWING ARRANGEMENT OF STAIRS, PLATFORMS, ETC., AT THE DAVIS ST. STATION (EVANSTON TRACK ELEVATION); C., M. & ST. P. RY.

The Calvary station is a little different from the others because of the small ground area and head-room available, and because of modifications made on account of the funeral traffic to Calvary Cemetery, whose entrance is directly opposite the station door. The routes used in reaching and leaving the platforms are the same as described for Davis St. with a few exceptions; (1) exit through the station is not possible, (2) 6-ft. gates next to the turnstiles are provided for caskets, and (3) 8-ft. (instead of 6-ft.) passages are provided around the building.

REINFORCED CONCRETE WORK AT STATIONS.—A considerable amount of interesting and complicated reinforced concrete work was required, owing to a number of conditions: (1) the position of the buildings within the limits of the embankment required abutments, retaining walls and wing walls, and in some cases overhead bridges to carry the tracks clear of the roofs; (2) subways and stairways were needed to provide access to the platforms; (3) canopies were required to shelter the exterior passages as far as the outside turnstiles; (4) it was required that a future third track could be provided without extensive reconstruction.

At the Dempster St. and Main St. stations the parapets over the portal of the subways and two wing walls keep the embankment from encroaching on the space required for the buildings and the side and rear passages. At the Davis St. and Calvary stations the buildings come under the line of present tracks and make overhead bridges necessary. These bridges consist of two abutments, two piers, and reinforced concrete deck slabs very similar in general arrangement to the subway bridges. The slabs between abutments and piers span the outside exit passages and the slabs between the two piers span the station building. On account of lack of space and in order to make a neater job, the piers for the track slabs were incorporated in the side walls of the station buildings. These piers were made long enough to take care of the slabs which would be required for the third track.

At Dempster St., where no supports were required for the present tracks, columns and footings for future use were constructed within the walls of the buildings. The reinforced-concrete piers built within the station walls are very similar in design to the piers for the subway bridges (described in the former article), consisting of a footing slab, footing girder, two columns per track and a top girder. The curved brackets are omitted.

The subways are of the same general type as the standard reinforced-concrete rectangular culverts of the Bridge and Building Department. They consist of two side walls designed as slabs to support the lateral pressure of earth, resting on footings of the required width necessary to provide sufficient bearing area, and spanned by reinforced-concrete cover slabs. The footings are carried down to the same level as the foundations for surrounding work. Struts between the footings take the horizontal reaction of the side walls. Ledges 4 ins. wide cast on the inside of the subway walls afford a support for the pavement or floor slab.

The stairways are designed in various ways, depending on conditions, but in all cases they consist of a reinforced stair slab spanning between two supporting walls. The stair slabs in the rear stairways rest on 4-in. ledges molded along the lower edge of the supporting walls. Footings on the natural ground afford a bearing for the middle of these walls and columns support each end. The tops of the walls are about 21 ins. above the base of rail. The stair slabs for the front stairways are also carried by two walls; the front wall, however, does not extend above the level of the stairs except near the top of the flight. The extreme ends of the supporting walls for the front stairways are not carried on columns; they are cantilevered instead, being tied back either to heavy mass abutments, to wing walls, or to the similar cantilever walls of the opposite stairway.

The subway floors and all the stair treads were cast after the supporting walls were in place, and they are finished with a 1-in. granolithic surface bonded to the slab. The subway floors are crowned and sloped toward the entrance of the passage. Bell-trap drains in the gutters catch the drainage from the stairways. The stairways have a rise of 7 ins. and a tread of 12 ins.; this tread includes a 1-in. nosing. There is a ¾-in. fillet at the intersection of the tread and the face of the riser. The top landing is at about the level of the base of rail, and a wooden flight continues the stairway from this landing to the level of the platform.

Reinforced-concrete slab canopies cover the exterior passageways in Dempster, Davis and Calvary stations at points where protection is not afforded by the track slabs overhead. At Main St. the conditions are a little different and the canopy is supported on heavy wooden brackets bolted to the side walls of the building, the roof being the same as that of the main portion of the building.

*A description of the track elevation work and structures, by Mr. Greifenhagen, was published in our issue of Feb. 10.

†Office Engineer; Bridge and Building Department, Chicago, Milwaukee & St. Paul Ry., Railway Exchange Building, Chicago.

The construction of piers to take care of the third track has already been mentioned. Wing walls running out as far as the toe of the present embankment are built at a considerable distance from the sides of the station in order to give as much light to the building as possible both under present conditions and after the construction of the third track slab. The footings for these wing walls are designed heavy enough to act as footings for the future abutment which will be built around the wings when the third track bridge is put in.

The footings for abutments, piers and subways were kept separate and proportioned to produce the same unit pressure on the foundation and thus prevent unequal settlement.

STATION BUILDINGS.—In planning the station buildings a number of requirements were kept in mind: double entrance doors, ticket booth with turnstile, space for second booth at some future date, an area in front of the stile, waiting room space beyond the stile, two toilet rooms, porter's closet, space for stove, rear exit doors (also side exit doors at Calvary and Davis St.) and two interior exit passages. All buildings have double entrance doors in front and double exit doors in the rear. Calvary and Davis St. stations have single exit doors on each side, opening on the front stairways. Interior exit passages are provided in all stations except Calvary and they have single doors at each end. The allowable width of Calvary station is small and interior exit passages could not be provided. With the exception of the roofs and cornices, the details of construction of all station buildings are practically the same.

The foundations at Main St. and Dempster St. are of concrete and of regular construction, carried deep enough to avoid frost action. At Calvary and Davis St., the foundations for the side walls are incorporated with the footings which carry the track slabs overhead. The front and rear walls are supported on concrete girders spanning between these side footings. A water-table carried up 7¾ ins. above the station floor level is molded separately from the main body of the footings.

Brick walls 13 ins. thick are built from the water-table to the bottom of the concrete cornice, or to the under side of the pitched roof, depending on the type of station. The exterior face brick for the main wall areas is light colored "oriental," and a medium shade of "oriental" is used for the projection quoins at the corners and offsets. This difference in color is to give contrast. The bricks are laid up in black mortar; the joints are ¼-in. thick and deeply recessed. A white enameled brick was decided upon for the interior after light colored pressed brick had been considered. The great need for utilizing all the reflected light possible in these small buildings, and the desirability of simplifying the maintenance, makes this brick the most economical in spite of its rather high first cost. The interior brick is laid up with ⅛-in. joints. The walls are filled with common brick and Portland cement grout, and wire bonds tie them together.

There are two types of roof: (1) In the Davis St. and Calvary stations, and the rear portion of Dempster St., the roof consists of a flat reinforced-concrete slab supported by the concrete piers which are built into the station walls. The cornices in these stations are of concrete cast with the top girders of the piers. (2) At Main St. and the front part of Dempster St. station, the roofs are of regular hip construction with a 3-ft. projecting cornice. The stations with flat roofs have a concrete cornice of modified classical outline, above which is a brick parapet with a concrete coping. This cornice is cast against the top girder of the piers which are incorporated in the side walls of the buildings at these stations. A reinforced-concrete roof slab spans between the concrete piers. At Davis St., the span of the roof is 18 ft., and in order to reduce the dead weight a concrete T-beam and tile construction was adopted. These flat roofs are waterproofed with a five-ply tar and gravel roofing. The pitched roofs are of timber, covered with red French tile. A rather heavy cornice is provided, suggesting the "bungalow" style. The gutter and face board are painted a dark moss green; the panelled ceiling of the cornice is painted a somewhat lighter green.

Since a maximum amount of natural light was desirable, as many windows as possible were placed in the side walls, due attention being given to exterior proportions. Transoms are provided above the doors, and a large panel in each door is glazed with plate glass. The partitions for the toilet rooms and porter's closet are of white enamelled brick laid up in single thickness and set upon a concrete base to match the water-table. The toilet rooms are lined with white enamelled tile. The ticket booths and all interior trim are of oak and have a dark greenish brown varnish finish. The glazing in the ticket booths is of ¼-in. clear wire glass. Flat steel-mesh screens are provided in a few of the panels of partitions and doors for the purpose of ventilation and transmission of heat. The interior passages are kept separate by ornamental iron hand-railings.

The floors are of 6-in. concrete with a 1-in. granolithic finish laid off in 6-ft. squares. The finish is colored and the surface is marked into 18-in. squares to relieve the dead effect of the ordinary cement floor. All plastering is on metal lath, except at Davis St. station, where it is applied to the bottom of the tile and concrete roof slab.

Stoves are provided for heating. The flues lead to a brick chimney in the Main St. and Dempster St. buildings. In each of the other two buildings a cast-iron flue is provided which passes through the ceiling horizontally along t roof and up the back of the platform canopi overhead.

All plumbing is open work and the fixtures a of "white metal," as the claim is made that ta nish can be readily removed from this met without injury to the polished surface.

The station, exterior passages, subways, an platforms are well lighted by electricity, an various circuits are controlled by the ticket agen by means of a switch box placed inside of th ticket booth. All wiring is done according to th national electrical code. All lights are 16 c. p incandescent lights connected in series, five light to a circuit. With this arrangement, the failur of any one light does not affect the lights in th remaining circuits. A train annunciator is placed in each station.

STATION PLATFORMS.—The platforms are from 225 to 240 ft. long and from 9 ft. 6 ins. to 10 ft. 6 ins. wide. Their floors are supported on the concrete stairway wall wherever possible, and beyond the stairways are carried by pile bents. There are two oak piles per bent, capped with a 10 × 12-in. timber, and the bents are spaced about 19 ft. 9 ins. Joists 3 × 12 ins., 20 ft. long, and well bridged every 5 ft., carry the floor-

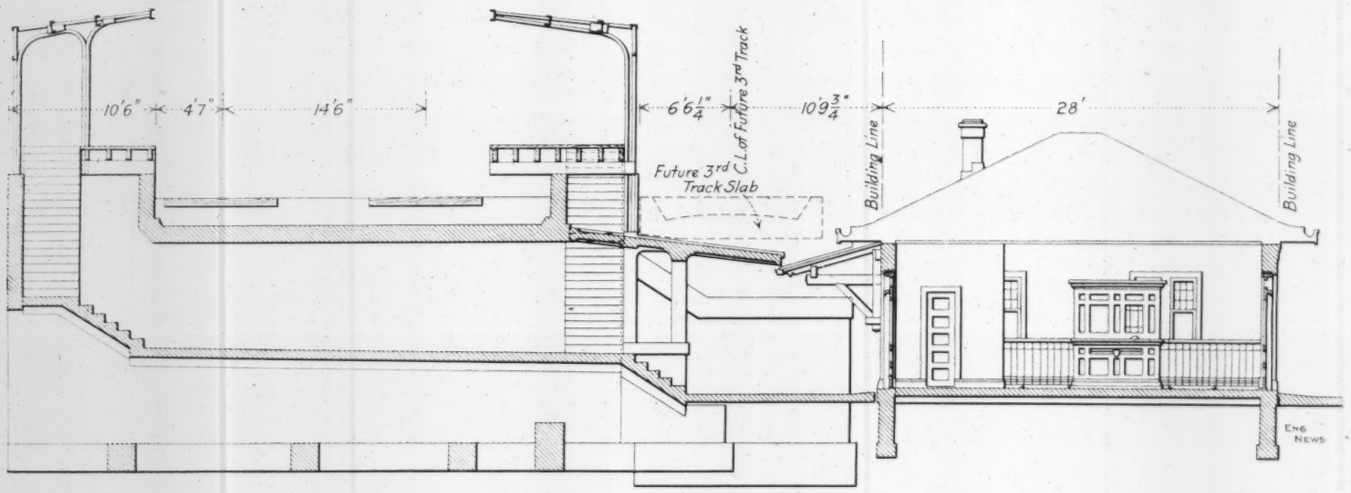


FIG. 2. CROSS SECTION OF MAIN ST. STATION, EVANSTON; C., M. & ST. P. RY.

ing of 2 × 4-in. planking laid with ¼-in. open joints.

The platform between the stair wells and about 25 ft. beyond are covered by corrugated iron canopies supported on structural steel brackets. The corrugated sheeting is carried on channel purlins running between the brackets, and the whole roof is sloped downward to the back of the platform. The columns of the brackets are placed along the back of the platform to leave the floor unobstructed. They are made up of plates and angles attached at the bottom by means of a gusset plate to a pair of channels. The channels are firmly bolted to pile bents or concrete walls and the connections are figured for wind loads on either side of the canopy. Fig. 2, which is a cross section of the Main St. station, shows the arrangement.

Latticed struts brace the tops of the brackets against longitudinal forces and relieve any strain between the purlins and their supports. The hand-railings between the canopy brackets are designed to serve as lower struts to relieve strain between the brackets and their anchorages. This hand-railing is provided with metal panels to carry billboards. A pipe hand-rail is provided along the face of the stairway walls.

The stations were designed and constructed by the Bridge & Building Department of the Chicago, Milwaukee & St. Paul Ry., under the direction of Mr. C. F. Loweth, M. Am. Soc. C. E., Engineer and Superintendent. The construction and design, respectively, were, in a general way, in charge of L. D. Hadwen and J. H. Prior; and were directly in charge of R. J. Middleton and E. O. Greifenhagen, the latter being the writer of this article.

Reinforced Concrete Girder Bridge at Stakeford, Eng.

A recent number of the London "Engineer" describes in some detail a concrete girder bridge which has recently been built across the river Wanbeck, at Stakeford, Eng. There are a number of details in this bridge that seem worthy of note, particularly the novel pier construction and the light abutments. The general design of the bridge is shown in Fig. 1. It consists of six skewed spans, four of 44.4 ft. span and two of 42.4 ft., each made up of two girders carrying crossbeams and a slab floor, on which is placed a macadam roadway, 18 ft. wide, and one concrete sidewalk 4 ft. wide.

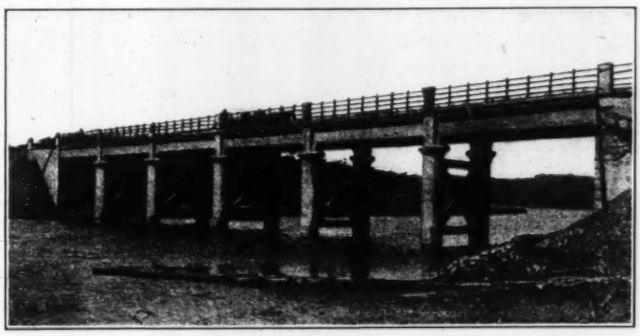


FIG. 1. VIEW OF THE COMPLETED BRIDGE, STAKEFORD, ENG.

The ground underlying the river is of gravel, sand and clay in strata above a yellow sandstone, and it was thought necessary to get the footings down to this latter rock. For this, square previously-cast Hennebique concrete piles were driven in both the abutments and piers. The abutments are founded on these piles, in depths ranging from 20 to 40 ft., on the corners and along the sides of the U-section shown at the left of Fig. 1. Each abutment is a framed box, consisting of columns above the piles and connected with 6-in. outside walls to the ground surface and interbraced with the beams shown at the level of the pile tops and also just below the roadway surface. This hollow box is filled with earth and stones to form a foundation of the roadway.

Each of the piers consist of two columns, braced transverse to the bridge, as shown in Fig. 2. As in the abutments, the columns of the pier are formed on piles driven to rock. These 14-in. piles were designed to project a short distance above the river bottom and over them were lowered successive sections of 48-in. drain reinforced-concrete shells, terminating at the top, as shown, with a curved coping. These shells reached just to the river bottom. Inside of them reinforcing rods were placed and then concrete filling, making a solid column 48 ins. in diameter, and upon their top the main girders were cast in place. The cross-bracing of the piers is heavily reinforced, especially where it enters into the openings in the shells, so as to make a solid connection there.

The main girders are of the regular Hennebique type, reinforced as shown in Fig. 3. On account of colliery workings immediately underneath the bridge, there is a possibility that some time in the future there may be a subsidence of the foundations, but on this account the spans have all been designed independently of each other, and the advantage in reinforcing due to a continuous beam assumption has not been taken. Thus, over each pier (Fig. 3) the main girders increase from their regular width of 14 ins. to 29 ins., and there is a complete opening between the adjacent beams, screened from the outside by a fascia block. If there is any sinking under one pier in the future, the injury to the bridge will, therefore, be confined to the two spans resting on that pier.

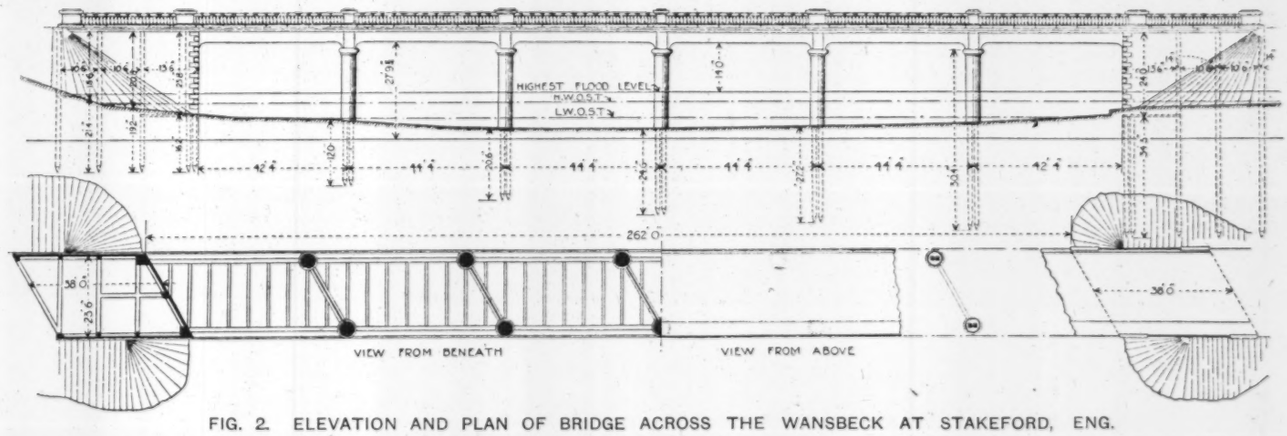


FIG. 2. ELEVATION AND PLAN OF BRIDGE ACROSS THE WANSBECK AT STAKEFORD, ENG.

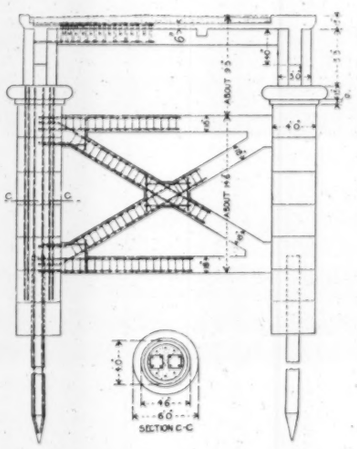


Fig. 3. Transverse Section at Pier.

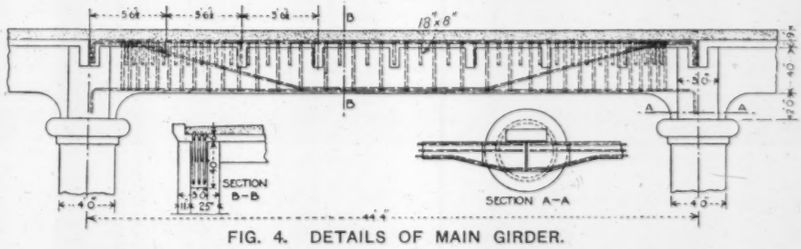


FIG. 4. DETAILS OF MAIN GIRDER.

State Conservation of the Water-Powers of New York.*

New York distances all other states in the gross total of hydraulic power in use. It was also the first state to undertake a careful estimate of its water-power resources with a view to a comprehensive public policy for their development. The statute directing this investigation (Chap. 569, Laws of 1907), together with the action of Governor Hughes in establishing the principle that payment must be made to the state for water-power franchises, marked one of the earliest efforts toward state control of the development and use of water-powers for the public benefit. But if area and population, as related to natural advantages, are taken into account, New York has been greatly outdistanced by her New England neighbors, which, under favoring laws, have pushed utilization of their water-power resources well toward the physical limit.

The Commission estimates that no less than a million and a half horsepower can be ultimately developed on the interior streams of New York, without counting the Niagara and St. Lawrence Rivers. This great reserve of power, equal to nearly a third of all the water-power in use in the United States, would be sufficient to displace all the power now derived from coal, and to provide the state with all the motive energy it will need for as many years as anyone can see. To reach this great figure of 1,500,000-HP. development there would be required the most thorough and scientific control of these water resources by an authority no less than that of the state.

The Commission estimates that the 1,500,000 HP. of water energy now running to waste in New York would have a yearly rental value of at least $15,000,000 if properly controlled, and that there is an increasing demand by the public for such control and a growing market for its use, as the power to transmit electricity and the multiplied uses to which it is being put increases the market demand. The commission believes that sufficient data have now been gathered to warrant the immediate adoption of a state plan of water-power conservation and that the economic and social welfare of New York demands the early announcement of some definite policy under which the improvement of water-power can be commenced and further detailed surveys made as rapidly as the needs of different sections shall demand.

The watersheds of the Hudson, Genesee and Raquette Rivers have been thoroughly examined and their water storage opportunities investigated and surveyed. Four great reservoir projects of water storage for power development and flood control have been located, surveyed, mapped and described from the point of probable costs and benefits, in detail. These are the Sacandaga and Schroon Lake reservoirs on the Hudson drainage, the Portage reservoir on the Genesee and the Tupper Lake reservoir on the Raquette.

*From an official abstract of the Fifth Annual Report of the New York State Water Supply Commission, submitted to Governor Hughes on Feb. 1, 1910, for transmission to the Legislature.

Sufficient investigations have been made to establish the right of the Oswego, Black and Oswegatchie watersheds to be included with the three streams named in the list of six internal rivers of New York as most important in point of view of water-power developments and possibilities. In addition to these, investigations have been made of the Salmon River in Oswego County and in Franklin County, the Grasse, St. Regis, Chateaugay, Chazy, Saranac, Ausable, Boquette, Susquehanna including the Chenango, the Allegany including the Canisteo and Chemung, Cattaraugus Creek and minor streams flowing into Lakes Erie and Ontario.

Comprehensive State Policy Urged.

To quote directly from the report:

The state should seize this opportunity to mark out a policy with respect to its waters which shall establish once and for all the principles and procedure for their use and control, whether for municipal or power purposes or for securing the incidental benefits to navigation and to the public health and safety which are sure to result. * * * Unlike many other states, New York has never under general laws granted the right of eminent domain to individuals or corporations for the purpose of flooding lands to create storage ponds and develop water-power. Unless the state shall define its policy and enter upon the work of carrying it out, this feature of its natural resources must largely remain in its present undeveloped condition, or be subject to the same haphazard and uncontrolled methods of utilization that have governed in the past. As adequate reservoirs cannot be generally constructed for power purposes by private enterprise without a constitutional amendment, and possibly not then, the better way to accomplish this object is for the state itself to announce its policy and undertake its performance in the interests of all classes and citizens.

Advantages of State Control.

* * * * * * *

The prime, inclusive reason for the exercise of state authority over the control of stream flow for power development is that under modern social and economic conditions this step is necessary to ensure the equal participation of all citizens in this form of natural wealth, which is peculiarly the heritage of the whole people. The state is the proper authority to undertake and carry out the conservation of its own water resources. The advantages to be gained by the state in dealing with this natural resource have been forced upon the public mind none too soon. Even though the profits may not appear generous in the near future, our own experience and the experience and observation of our neighbors show that in the not distant future ample returns will result from all possible outlay. The next generation will either command our efforts for prompt action or condemn us for inexcusable delay.

* * * * * * *

It does not seem to this Commission that it should be necessary to urge upon the state the importance of conserving its natural resources. It should be sufficient simply to point the way, so that the Legislature with the provision of statesmen may adopt the necessary measures. We have no hesitation in saying that the regulation of stream flow and the general conservation of the state's water resources is a state function, and that this state should continue to lead all others in so important a matter by enacting the required legislation, and, if necessary, by amending its fundamental law.

State Lands Required.

The total number of acres of State land that would ever be flooded on all the principal Adirondack streams, if all feasible storage reservoirs were constructed, would be 55,000. The report says:

This is a most exhaustive figure, including many reservoirs likely to be built only in the distant future, if ever; others which would not be built in case of the construction of alternative reservoirs on the same stream, and also taking into account state lands under waters already stored for regulation purposes. Even this total of 55,000 acres is only 3.9% of the state's holdings in the Adirondacks. Of this amount about four-fifths, is low and swampy land or, as in the case of the 9,680 acres on the Black and Oswegatchie Rivers, is already under water. Only 11,000 acres, or less than 1% of the state land in the Adirondacks, is timber land of value for forest purposes.

The Commission has no hesitation in asserting that the state in carrying out this project may safely put a limit on its own action by providing that not more than 43,500 acres of land now in possession of the state should be flooded in order to prevent any improper or wholesale flooding of state lands. It is important that any amendment to the Constitution should be thoroughly studied, carefully considered and so clearly expressed as to prevent any possible violation of its purpose, such purpose being the flooding of state lands by reservoirs built, owned and forever controlled by the state. Such an amendment might refer to the several reservoirs stated above and limit the lands to be taken in each instance to a specified number of acres, or the amendment might provide that the land to be so utilized by the state should not at any time exceed 2% of the state's holdings within the boundaries of the Adirondack Park.

The report also suggests that whenever a reservoir is constructed by the state involving state land, the actual cost of the portions of state land taken shall be considered a part of the cost of the project and included in the estimate thereof. When the reservoir is built a corresponding sum would be transferred from the water storage fund to the fund for purchase of forest lands and the Land Board required to purchase therewith new and more desirable forest lands to be added to the forest preserve in place of the generally low and swampy lands which would be converted to water-storage purposes.

In recommending the adoption of a state plan of development of water-powers, the Commission adds:

It appears from the studies already made by this Commission as heretofore stated that fully 1,500,000 HP. of water energy is running to waste in the state and that this water-power has a yearly rental value of at least $15,000,000 when properly controlled. There is a growing demand by the public for such control and also a growing market for its use. The power to transmit electricity and the multiplied uses to which it is being put increases the market demand. For interest charges on the costs of construction, maintenance and operation $3,000,000 per year is a large allowance, having a net annual value of $12,000,000 which might be reclaimed from this waste product of nature. The state and its subject would be in this way directly benefited. The indirect benefits to the state will be much greater. Counting the families of those to whom employment will be afforded and the storekeepers, farmers, mechanics, and business and professional men indirectly supported, it may be safely said that at least one person is supported by every 4 HP. developed.

* * * * * * *

The passage of a law that permits the use of natural resource for new purposes is well within the general definition of public use as established in various decisions of the courts. Building a storage reservoir will stimulate industrial energy and promote the productive power of a very large population in the portion of the state affected, besides leading to the growth of towns and the creation of new channels for the employment of capital and labor in those other centers and places to which electrical energy can be carried. So all over the state industrial opportunities are waiting for a strong and skillful hand to apply the electric spark that will set in motion many hands and wheels. A general policy for the systematic development of the state's water resources would quickly become an important factor in the general welfare of all our people and, therefore, has a real *"public purpose."*

Should the courts finally say that under the Constitution the building of reservoirs by the state as herein recommended is not a public purpose, then certainly we as a state have defined our policy none too soon. It would immediately become our duty to follow the example recently set by the Swiss Republic when it saw its splendid water resources running to waste with no power in the Cantons to conserve and control them. We should amend our Constitution as they did theirs, in order that the state's water-power resources may be developed systematically for the benefit of the people of the state.

The recommendations of the Commission include the proposed amendment of the Constitution with reference to the use of state lands for reservoir purposes and a second amendment to the Constitution to permit the issue of water-storage bonds to provide for the construction of the storage reservoirs not to exceed the sum of $20,000,000. The bill which accompanies the Commission's proposed plan of operation provides for a general and systematic development of the water resources of the state. Under its provisions the initiative for building storage reservoirs may be taken by individuals, associations or corporations subject to the recommendations of the Commission and the approval of the Governor. All contracts for the acquiring of lands and the construction of reservoirs by the Commission must have the Governor's approval. The Commission is empowered to sell or lease the water stores in any state reservoir and to sell and lease power that may be developed thereby; it may make contracts for the payment of the amount of yearly benefits conferred by reason of regulating the flow of any stream upon which state reservoirs may be built and may provide the manner of assessing and collecting yearly benefits where contracts are not made. The purpose of the bill the Commission states is:

To devise a plan which when completed will yield a net revenue and conserve in the interests of the general welfare a great natural resource now running to waste.

In closing, the report states that:

An issue which the people of the state must determine is whether these great projects are to be constructed under new and special legislation, placing them frankly on the basis of development and improvement of water power or whether the attempt is to be continued to have them built under the existing river improvement law in the guise of benefit to the public health and safety. In the case of proceedings under the River Improvement Law, the total cost of the reservoir would be assessed on all the property benefited, including, under the present hypothesis, the power owners who would bear by far the greater share. This assessment once paid, the resulting benefit to the power owners would be perpetual without further cost. It is assumed that the state would continue to control and operate the reservoir but it would derive no revenue from the sale of the stored water. The benefits resulting to the public would be those of protection of the locality from flood damages, the possible increase in the depth of navigable channels and the undoubted stimulus which would result to the water-power industry creating more wealth and more valuable property to yield a greater return in taxes.

As opposed to this conception, the alternative is the present plan of the Commission on which involves a continual annual revenue from the sale or lease of the stored water even after the entire cost is defrayed. The revenue might well be altered and fixed on a basis to stimulate rather than discourage industrial developments. At the same time the fundamental principle would be asserted that the state which would control and improve the flow of its streams would be entitled thereby to a revenue, possibly subject to periodic readjustment but in theory, perpetual. These are the facts and the issue now before the people of the state.

IT MUST HAVE BEEN VERY COLD.—Montreal, Que., Feb. 7.—Cold was so intense this morning that a Grand Trunk locomotive, which had just backed into the Bonaventure station to pull out a train, froze to the track and delayed the train's departure for over an hour.—N. Y. "Commercial," Feb. 8.

Sidewalk Practice in Chicago.*

By N. E. MURRAY.†

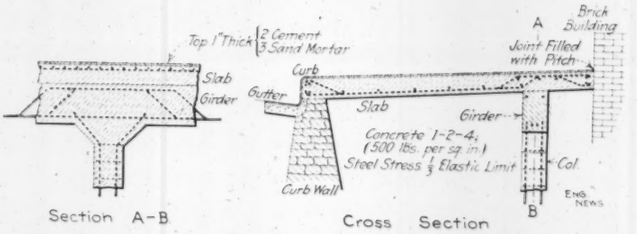
In 1897 the sidewalks of Chicago were in charge of a small force of clerks and five inspectors, who were expected to look after the sidewalk work of the entire city. With the exception of a contract-record book the sidewalk bureau had no records and no means of keeping track of its work. About 1898 the increasing total of personal injury claims began to receive publicity and caused some effort to be made to put the department in better condition.

When the writer took charge of the sidewalk bureau‡ in 1900, while it was in better shape (there being then thirty inspectors) it was far from being in a satisfactory condition. There were no ordinances governing the construction of walks or the issuing of permits for same, and as there were no standard specifications covering their construction, contractors laid cement walks in the manner that best met their own ideas and gave them the greatest returns for the least expenditure of labor and material. As a result, cement walks laid but two or three years were disintegrating and going to pieces, mainly from improper mixing, insufficient tamping and lack of cement. In March, 1902, the department succeeded in having the City Council pass a general ordinance embodying the different sidewalk specifications and fixing penalties for its violation.

Passing ordinances for individual streets was a slow method and the plan was adopted of making ordinances for walks on systems of streets sometimes covering a territory ½-mile square and calling for an outlay of more than $1,000,000. The passing and enforcing in 1902 of a general ordinance covering the construction of the different kinds of walks had a decided effect on the cost price and on the quality of the work.

Cinder Walks.

These are safe for outlying and sparsely settled territory, but can be recommended only for cheapness in initial cost and for the fact that they can later be used as a foundation for cement walks. The walk consists of not less than 12 ins. of cinders, usually deposited in two layers between two rows of 2 × 6-in. hemlock plank or curbs, nailed to split cedar posts set 4 ft. apart and driven not less than 15 ins. into the ground. The top of the curbing is set at the grade at which the walk is to be built (3 ins. below cement sidewalk grade) and backfilled with earth. The first layer of about 9 ins. can be either coarse cinders or slag. The second layer of 3 ins. should be of finer cinders. After these have been compared, a "crown" of fine clean cinders is put on and the entire walk rolled with a roller of not less than 500 lbs. Some contractors prefer tamping with a regulation concrete tamper to rolling.



REINFORCED-CONCRETE SIDEWALKS OVER VAULTS; CHICAGO.

COST.—Average bed of cinders, 1.2 ft. × 6 ft. = 7.2 cu. ft. in place. Allow for 20% shrinkage, = 9 cu. ft. loose.

	Cents.
9 cu. ft. or ⅓ cu. yd. at 50 cts. in place	16.67
Lumber at $17.50 per M. ft.	3.50
Stakes at 1 ct. per lin. ft. of material	1.12
Nails	.10
Waste on material, 1% of value	.21
Labor (incl. excavation and backfilling)	4.50
	26.10
Add for supt., office expense and profit, 15%	3.91
Average cost per lin. ft.	30.01

The cost of labor is based on an average of prices obtained from several contractors.

Cement Sidewalks.

The concrete base is 4¼ ins. thick; mixture, 1:2½:5; made with broken limestone, washed gravel or crushed blast furnace slag. The ¾-in. wearing surface consists of a 2:3 cement mortar made with screened torpedo gravel or granite screenings. This gives a 5-in. completed walk on a 9-in. foundation of broken slag, crushed stone, sand, cinders or other suitable material. These are being laid on residence streets and on busi-

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors at Cairo, Ill., Jan. 26-28.

†Superintendent of Sidewalks, Board of Local Improvements, City Hall, Chicago, Ill.

‡One of the four bureaus composing the department of local improvements, which is in charge of a board of five members.

ss streets where no use is made of the sub-sidewalk ace. Concrete walks on I-beams or of reinforced-ncrete construction, are used wherever sub-sidewalks ace is used. These are being laid as the standard, d are used almost exclusively.

LOCATION.—Under the ordinance of March, 1902, all alks (except full-width walks) must be laid on a line arallel to and 1 ft. from the lot line, except where herwise ordered by special ordinance. Often it is und necessary to change from the prescribed line in rder to save shade trees. The City Council (usually n petition from the property owners) sometimes passes n ordinance for laying the walk adjoining the curb, he plea being that this is necessary to save the build-gs from being defaced by children. The writer does ot favor the laying of walks adjoining the curb, be-ause it brings pedestrians in closer contact with the ust and dirt from the street, sprinklers, etc., and be-ause there is more liability of interference from street raffic and from horses hitched or standing near the urb.

FOUNDATION.—Filling to bring the sub-foundation o proper grade to receive the foundation should be deposited in layers of not over 12 ins., or 6 ins. if clay s used. Soft and spongy places should be dug out and replaced with suitable material, thoroughly compacted. Where excavation is necessary, it should be done to a depth of 14 ins. below sidewalk grade; and when required, suitable drainage should be provided. The foundation or sub-base should be of clean, hard cinders, slag, crushed stone, sand, gravel, broken bricks or other similar materials, and should be of a depth of 9 ins. after being thoroughly compacted. The foundation should be kept wet while the concrete is being laid.

MATERIALS.—The cement should be finely ground, uniform as to quality and color, delivered on the work in original packages, and kept dry until used; lumpy cement should not be allowed.

The sand should be clean, sharp, free from foreign substances, of sizes ranging from ⅛-in. down to the finest, and in such proportions as to give a maximum of density and a minimum of voids.

Granite screenings are too expensive except for the wearing surface, and when used for that purpose should be clean, dry, well graded, free from excessive dust and of sizes similar to those specified for sand. The use of limestone screenings in sidewalk concrete is not advised. The writer is well aware that screenings have shown very high in laboratory tests, both in crushing and tensile strength, but unfortunately they have not shown the same high efficiency when put to a practical test in sidewalks actually constructed, but have proved an almost complete failure.

Many concrete walks in Chicago which were laid from 8 to 12 years ago, with limestone screenings in the base, were torn out and relaid this year, having failed completely. This may have been due partly to the quality of screenings used, and (to some extent) to an insufficient amount of cement. At any rate, when the top composed of torpedo sand and cement was removed, the base could in almost every instance be shoveled out without being picked. While limestone screenings may have proved a success in concrete used in foundations and underground work, they certainly have not been a success in sidewalk concrete where they were more exposed to the elements and to extremes of heat and cold.

The stone or gravel should be clean, sound, free from dust, loam, dirt and other foreign substances, of sizes not less than ¼-in. nor more than 1-in. in any dimension, and graded in such proportions as to give a maximum of density and a minimum of voids. For reinforced concrete, the stone should be not more than ¾-in. in any dimension. The writer has experimented with crushed blast-furnace slag as a substitute for crushed limestone or gravel as the coarse aggregate, and to date has not recorded a single failure. The ordinance has been amended to allow the use of this material in concrete both in sidewalk and pavement construction.

FORMS.—The wooden forms should be smooth, free from warp, and not less than 2 ins. thick and 5 ins. deep. They should be set to the lines and grades given by the engineer, their upper edges conforming to the grade of the finished walk, which should provide for a fall from the lot line to the curb line of 1 in. in 3 ft. for proper drainage. The work should be blocked out in sections about 5 × 6 ft., the cross forms (5 ins. deep) extending full width of the walk and set at right angles to the side forms. For walks 5 ins. thick the blocks should not be over 6 ft. in any dimension. Expansion joints 1 in. wide should be provided at least every 100 ft. and at all street and alley returns.

PROPORTIONS.—Materials for concrete should be proportioned according to the voids in the aggregate, which varies with different materials. Owing to the many sources from which the different materials for walks were received, and the large number of gangs (over 300) using them, it was found impossible to follow this method in Chicago. This forced us to adopt an arbitrary mix proportioned as follows: (1) for base, 1:2½:5. (2) For wearing surface, 2 parts cement to 3 parts screened torpedo gravel or clean granite screenings. These proportions have been incorporated in our specifications as a part of our sidewalk ordinance.

MIXING AND LAYING.—For the 4¼-in. base, the sand for a batch should be spread evenly on a watertight platform and the proper proportion of cement spread on the sand. They should be mixed dry until the mass is of a uniform color and no streaks of cement show. Water should then be added and the mixing continued until mortar of an even consistency is obtained. Then the required stone or gravel (previously drenched) should be added and the mixing continued until each particle of the aggregate is thoroughly coated with mortar. If additional water is needed during the mixing, it should be added in the form of a spray. A medium dry mix is considered better than a wet mix for sidewalk concrete. Machine mixing is preferable to hand mixing, whenever a mixer can be used to advantage. After being mixed, the concrete should immediately be deposited on the foundation and tamped or rammed until solid and a film of moisture appears on the surface. The top of this course when completed should be a plane parallel with and ¾-in. below the grade of the finished walk. The cross forms should then be removed and the material for the next block deposited to preserve the joint.

For the ¾-in. wearing course, the mortar (2 parts cement and 3 parts torpedo sand or granite screenings) should be mixed as above, with sufficient water to obtain a consistency that will not require tamping but will be readily floated with a straight edge. When partially set, the surface should be troweled until a smooth, even surface is obtained.

BACKFILLING.—Where walks are laid on a fill, they should be backfilled with earth or sand in such a manner as to leave a berm of 1 ft. on each side of and flush with the top of the finished walk, with a slope of 1 in 1½ to the surface of the ground.

COST.—The cost of cement walk will vary with the cost of the materials delivered on the work, the cost of labor, the experience of the workman, the location and size of the piece of work to be done, the depth of filling, etc. It costs much more to deliver mixed concrete on a foundation 5 ft. above the ground than one 6 ins. above the ground. The average cost of cement walks laid in Chicago from 1901 to 1908, inclusive, based on the total cost ($8,918,278) divided by the total mileage (1,862) was $4,787 per mile, or 15.11 cts. per sq. ft. This price was for walks complete, including filling, which in many instances was from 2 ft. to 6 ft. in depth and is not a fair average cost for the ordinary cement walk.

Taking 1909 Chicago prices for labor and material, and using Taylor and Thompson's tables for quantities of cement and aggregate, we have the following average cost of material delivered on the work:

Cinders, 50 cts. per cu. yd.; cement, $1.20 per bbl. (3.8 cu ft.); sand, $1.75 per cu. yd.; gravel, $1.50 per cu. yd.

The ordinary concrete sidewalk gang in Chicago is usually composed of six men paid as follows (for 8 hours): 1 finisher at 65 cts., $5.20; 1 helper at 47½ cts., $3.80; 4 laborers at 37½ cts., $12; total, $21. Under favorable conditions this gang will construct 900 sq. ft. of walk per day. From information furnished me by several leading contractors, each employing on an average of six gangs of men, a gang of six men will average only 600 sq. ft. per day for an entire season. This figure will be used as a basis for computing the cost of labor in the accompanying table:

COST OF CONCRETE SIDEWALK CONSTRUCTION IN CHICAGO.

Cinders (allow for 20% shrinkage), 20.83 cu. yds. at 50 cts.		$10.42
Base, 4¼ ins. (1:2½:5):		
Cement, 9.77 bbls. at $1.20	$11.72	
Sand, 3.47 cu. yds. at $1.75	6.07	
Gravel, 6.85 cu. yds. at $1.50	10.28	
		28.07
Wearing coat, ¾-in. (2:3):		
Cement, 5.56 bbls at $1.20	6.67	
Sand, 1.17 cu. yds. at $1.75	2.04	
		8.71
Water, at 1 mill per sq. ft.		.60
Labor, one gang one day		21.00
Use of tools, waste of material, etc., at 2%		1.37
Supt. and office expenses, at 5%		3.51
Profit at 10%		7.36
Total		$81.04

Average cost, 13.51 cts. per ft. when 600 sq. ft. per day are laid, divided into unit cost per sq. ft. as follows:

Cinders		$0.0175
Base: Cement	$0.0195	
Sand	.0101	
Gravel	.0171	
		.0467
Top: Cement	$0.0111	
Sand	.0034	
		.0145
Water		.0010
Labor		.0350
Tools, waste, etc., 2%		.0023
Supt., 5%		.0058
Profit, 10%		.0123
		$0.1351

The cost of materials and water (7.97 cts. per sq. ft.) will remain constant, while the cost of labor, superintendent, etc., will vary according to the number of square feet laid per day, per gang.

Average sq. ft. per day...	700	800	900	1,000
Cost of labor, Supt., etc..	$0.1291	$0.1248	$0.1213	$0.1185

VAULT-WALK CONSTRUCTION.—It is customary to utilize the space under the sidewalk, between the curb and building lines, for private purposes, mainly for storage of merchandise and coal. This involves the construction of a self-sustaining covering which serves also as a sidewalk. When constructed simultaneously with a new building, the walk is practically an extension to the curb of the first floor of the building. It is customary to rest the outer end of the walk, with an even bearing of not less than 8 ins., on the curb wall.

The specifications provide for I-beam and concrete construction and permit any other construction capable of "sustaining a distributed safe load of 300 lbs. per sq. ft., including weight of walk." The slabs for reinforced-concrete vault walks are designed to sustain a uniform load of 300 lbs., including weight of slab.

It is evident that the specifications in regard to loading are at variance with the usual practice of designing for an assumed live load plus the dead load. It would be more logical and more economical to provide for a live load of 150 to 200 lbs. per sq. ft. in addition to the weight of the construction. The present requirement, however, errs on the side of safety, and secures a fair average.

With I-beam construction, the beams are extended not less than 6 ins. into the building wall. Where conditions do not permit of this, the I-beams are framed into or supported on a girder beam of the proper size and usually 1 in. deeper than the I-beam. The girder is supported by round cast-iron columns, spaced not more than 8½ ft. apart, resting on 12 × 12 × 1-in. flat iron plates imbedded in a concrete footing. This footing must be not less than 18 ins. thick and of a surface area determined by the bearing power of the soil (but not less than 4 sq. ft.). The I-beams are 5 ft. apart, and the concrete is 4 ins. deep over the beams and 6 ins. at the crown of the arch.

In recent years it has become the custom to substitute some form of reinforced-concrete construction for the usual I-beam vault. The allowable stresses are all conservative, being about 25% of the elastic limit for steel, and about 20% of the ultimate strength for concrete. The slabs are proportioned to fail by tension in the steel.

In the design of girders, web reinforcement must be provided when the safe vertical shearing unit stress exceeds 10% of the safe fiber stress. The girder may be placed at the free end of the slab or placed one-fifth of the clear span from that end. The reinforcing in the slab must in the latter case be reversed (as shown in the accompanying cut) to provide for a cantilever loading. The girders are supported by concrete columns from 8⅓ to 12½ ft. apart, usually 12 ins. square and reinforced with four ¾-in. round bars, 2 ins. from each corner. These bars are tied with ⅛-in. to ¼-in. wire, spaced not more than 12 ins. These columns rest on plain footings of proper area, determined by the bearing power of the soil.

To prevent shrinkage or temperature cracks, it is customary to place and tie bars across the main reinforcement equal to 0.3% of the cross-section area of the walk. These bars can be placed to serve the purpose of maintaining the spacing and as anchorage to the main reinforcement, as shown.

A combination of I-beam and reinforced-slab construction is frequently used. The I-beams extend across the span, and are usually spaced 5, 6 or 8 ft. apart. They are entirely enclosed in concrete and connected across the top with a slab of concrete reinforced with the proper amount of steel, usually in the form of a wire mesh. There is a saving in both concrete and dead load over the ordinary arch concrete I-beam construction.

No definite cost prices can be given for vault construction, as each job represents a special condition and no two are alike. One may require the partial rebuilding of a curb wall; another may require the building of an area wall, or the use of columns or piers. Each walk usually has from one to five coal holes to be fitted with iron "thimbles" and covers. In some, provision must be made for trap door or stairway openings. In others, for prismatic lights, etc. The prices range all the way from 38 to 55 cts. per sq. ft. for walks complete, according to the requirements.

POWER FROM THE BALTIMORE SEWAGE PURIFICATION works effluent will be one of the unique features of the plant now under construction for that city. We are informed by Mr. Calvin W. Hendrick, Chief Engineer of the Baltimore Sewerage Commission, that the disposal plant

has been so designed that the flow of the purified sewage from the plant to the river will have sufficient fall to operate turbines, which in turn will run dynamos generating electricity which will be used for flushing, pumping and lighting. In other words the flow of the sewage will give sufficient power to operate the plant, thus utilizing power otherwise wasted, reproducing the Niagara Falls plant on a small scale.

Paxton Creek Flood Controlling Works, Harrisburg, Pennsylvania.*

By R. M. RIEGEL.

General Description.

Among recent constructions of interest, the lately completed flood prevention works at Harrisburg, Pa., are of some importance, not so much on account of the magnitude of the works, as because of their marking a somewhat new departure in public policy. According to the 1907 Report of the Board of Water Supply of Pennsylvania, this construction is the first of its kind in the state, and marks a distinct step in the direction of the proper use and regulation of streams. The work was primarily an effort of the municipality to protect the property of its citizens from frequent damage from floods and to enhance the value of property previously menaced with such damage; incidentally it also forms a feature of the park system of the city.

Paxton Creek, which is a stream having a drainage area of about 23 sq. miles, flows through some of the foothills of the Alleghenys to the valley of the Susquehanna, turning abruptly at right angles about 2,000 ft. from the river bank, and thence flowing parallel therewith for nearly six miles and passing through a portion of the city of Harrisburg. The stream has always been subject to sudden and rather severe floods which caused much inconvenience and no little damage to owners of property in the city along the banks of the stream. While the dwelling houses were of no great value, considerable obstruction from backwater ensued in the main business streets of that portion of the city, and there has long been a demand for the abatement of the nuisance.

In accordance with a general scheme developed several years ago and including a number of municipal improvements, works were constructed last year by the Board of Public Works of the city, under the plans of Mr. James H. Fuertes, M. Am. Soc. C. E., which would prevent the effects of these frequently recurring floods. As the plans included the creation of an artificial lake over a mile long, the interest of the Park Commission was aroused, and the outcome was the embodiment of the lake in an extensive park development in this section.

The scheme of the Controlling Works, which may be comprehended by reference to Fig. 1, provides protection by the diversion of a portion of the flood waters directly to the Susquehanna River through a large flood channel, with an additional provision of sufficient storage capacity in the reservoir to carry the peak of the maximum flood to be expected. The site, which was practically level, allowed of the construction of a dam and a dike, which, besides keeping water in the reservoir at a normal depth of about 4 ft., would allow of the storage of an additional depth of 6 ft. over an area of between 150 and 160 acres for short periods.

By taking advantage of certain existing conditions, the city was able to construct the reservoir at comparatively low cost. An earth dam was constructed completely across the valley of the creek about 1,300 ft. long on the crest and having an average height of 12 ft. Thirty odd years ago a railroad fill had been built part of the way across the valley and this fill was incorporated into the dam, thereby saving about half of the necessary yardage. Running parallel with the steep hills on the east side of the reservoir and at an average distance from them of 800 ft., was the abandoned Pennsylvania canal. The east embankment of the canal was enlarged and its height increased by 4 ft. over a length of about 8,000 ft., extending from the south end to high ground at the north end. The balancing reservoir was thus formed by the combination of the dam at the south end, the enlarged tow-path or dike along the west side and the hills along the east side and north end.

The creek flows into the reservoir at its south end just above the dam, while the conduit for the diversion of the flood waters leaves the reservoir at its northern end. This conduit, of reinforced-concrete construction and about 2,000 ft. in length, was built under ground. Part of it lies under a public highway, and part passes through fields to the river. Probably the most interesting portion of the entire work was the construction of this conduit in the highway where it passes through a subway under the eight tracks of the main line of the Pennsylvania Railroad. The conduit was designed to discharge about 1,500 sec.-ft. with the Susquehanna River at its highest recorded stage and for the most part was built with a dished bottom and a circular arched top.

Before the construction of the Controlling Works the swampy land submerged had been crossed by two small streams and in order to avoid legal complications that might arise from interference with the flow of these streams as well as that of Paxton Creek itself, it was necessary to make provision for the maintenance, unchanged, of the natural dry-weather flow of each stream. To this end three weirs were constructed, each near the natural channel of one of these streams, and set at the same level, the length of these weirs being proportionate to the areas of the water-sheds of the three streams, *i. e.*, of Paxton Creek and the two small runs just mentioned. Connected with these were conduits extending under the dam and dike and emerging into the natural channels of the streams outside the reservoir. In each case the capacity of the conduits was limited, both by a square entrance orifice and by the size of the channel, so that

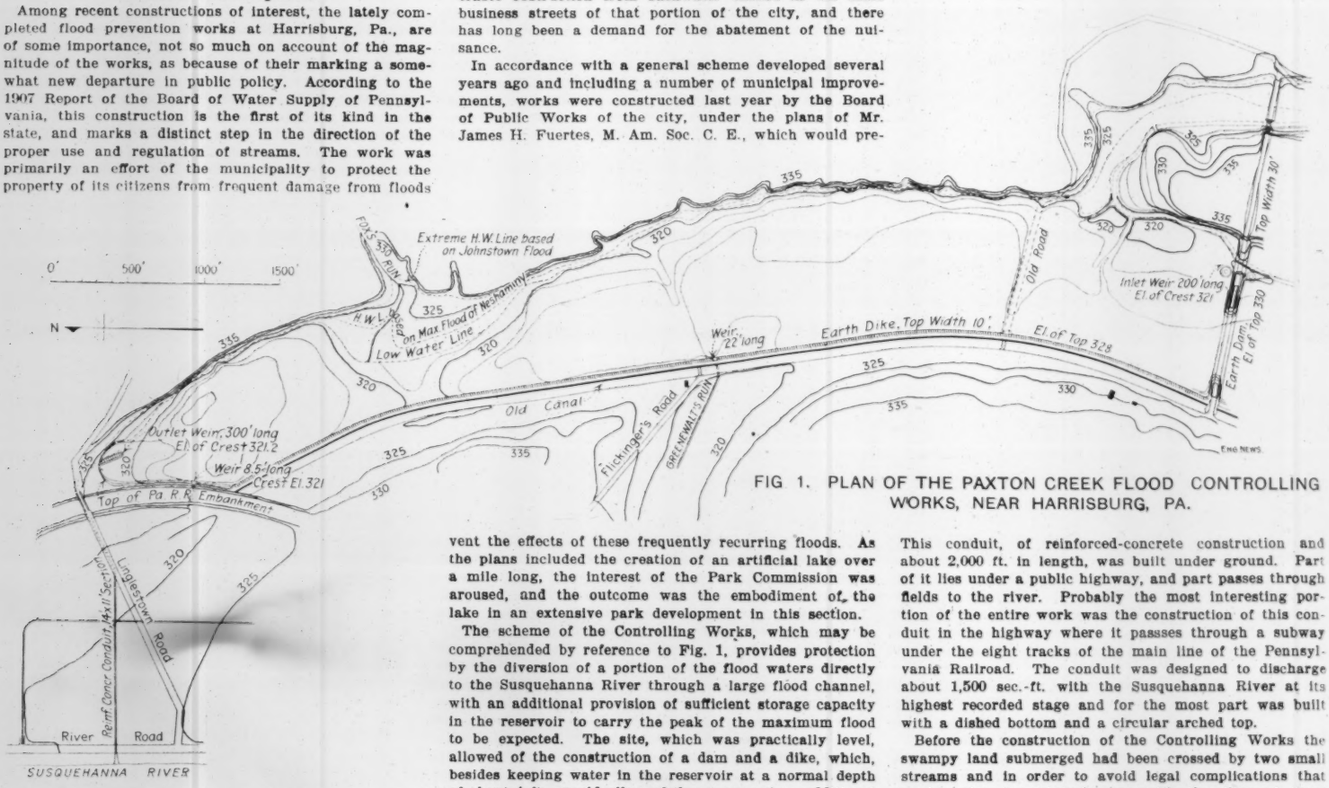

0' 500' 1000' 1500'
N
Extreme H.W. Line based on Johnstown Flood
H.W.L. of 1894 on Max Flood of Neshaminy
Low Water Line
Weir 22' long
Earth Dike, Top Width 10'
El. of Top 328
Old Canal
Old Road
Top Width 30'
Inlet Weir 200' long El. of Crest 321
Earth Dam El. of Top 330
Flickinger's Road
Green Walt's Run
Outlet Weir, 300' long El. of Crest 321.2
Weir 8.5' long Crest El. 321
Top of Pa. R.R. Embankment
Reinf. Concr. Conduit 14'x11' Sect.
Langlestown Road
River Road
SUSQUEHANNA RIVER
Eng. News.

FIG 1. PLAN OF THE PAXTON CREEK FLOOD CONTROLLING WORKS, NEAR HARRISBURG, PA.

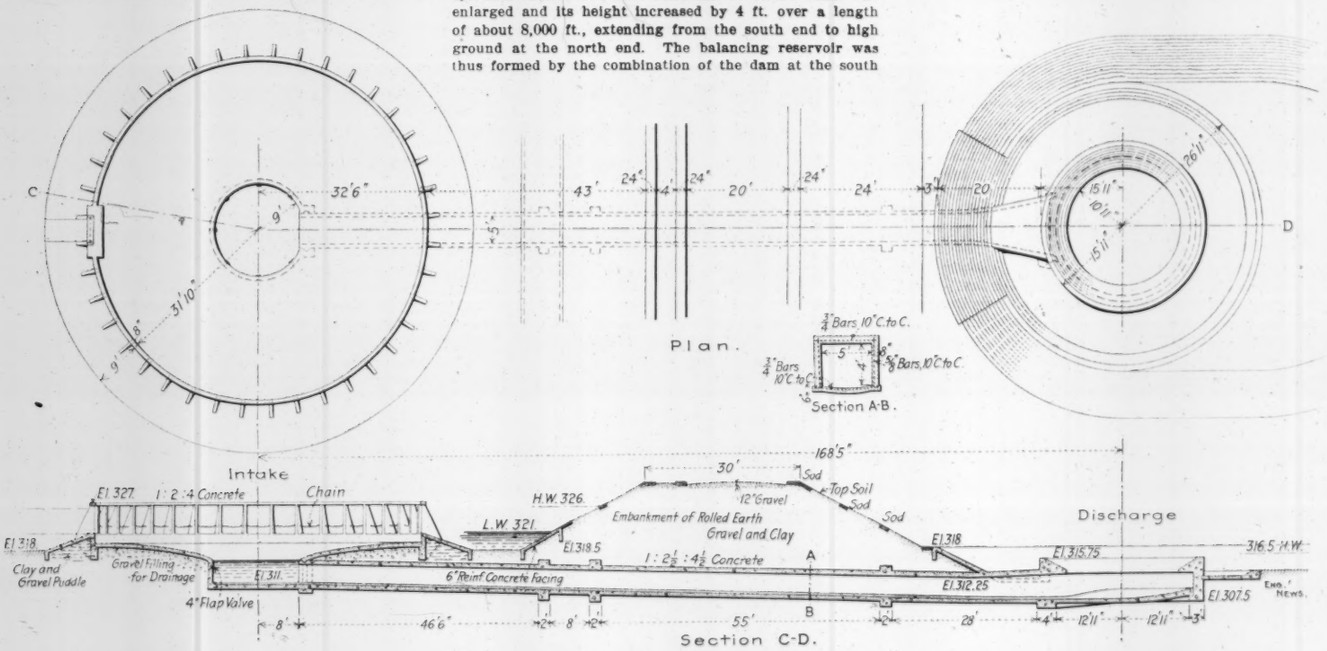


FIG. 2. DETAILS OF MAIN WEIRS AND DAM.

*From "The Cornell Civil Engineer," Oct., 1909, the monthly publication of The Association of Civil Engineers of Cornell University.

Note: The cuts and half-tones reproduced here were made directly from drawings and photographs furnished us by Mr. James H. Fuertes.—Ed. Eng. News.

en under the maximum possible head over the weirs e discharge through the openings would be kept within stablished limits. This was particularly true of the nduit under the dam, whose purpose was to permit the rmal flow of the creek to pass down the regular chan-

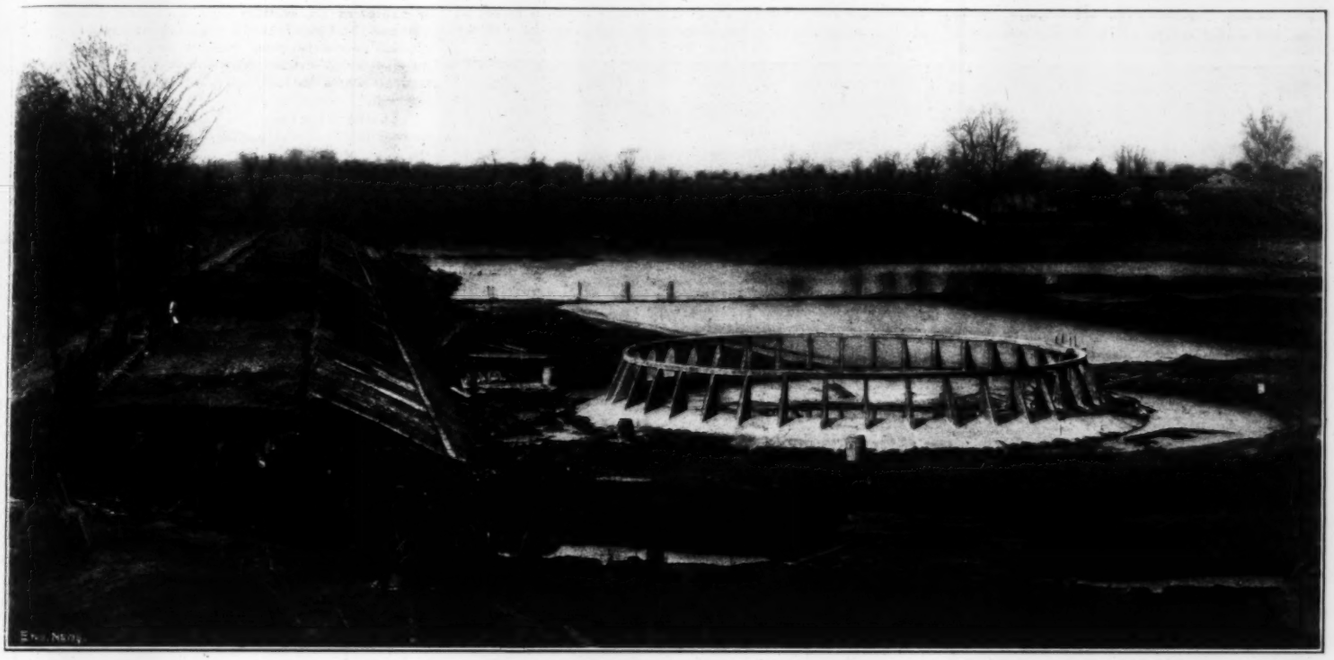


FIG. 3. VIEW OF INLET WEIR AND DAM.

nel through the city, where it was used to some extent for manufacturing purposes; and at the same time so to restrict the flow at times of flood that no more than 300 sec.-ft. could flow through it. This amount would not fill the banks of the creek below the dam, and would consequently cause no damage or inconvenience.

The entrance of the diversion channel at the north end of the reservoir consisted of another weir whose crest length was about 331 ft. and which was set with its edge 0.2 ft. above the other weirs. Under normal circumstances no flow would pass over the diversion weir and the flow through the three other outlets would be proportional to the water-shed areas of the several streams.

This work was begun in May, 1908, and was finished in January, 1909. Since that time two floods of considerable magnitude have occurred in the creek and have been successfully handled. The very dry weather, which rendered the fall months of 1908 so noteworthy, materially aided the progress of the work, which otherwise could scarcely have been completed before well on in the following season. This was especially true of the earthwork, of which some description will be given below.

The first thing to be done was to clear the reservoir and burn the cuttings and grass. In addition to this the sites of the dam and dike had to be grubbed free of stumps and roots as far as possible. This grubbing covered about eight acres of ground and was quite an undertaking in its way, all of the work having to be done by hand with axe and mattock.

Details of Dam.

The plans called for a dam of rolled earth with a concrete facing upon the slope exposed to water. Fig. 2 shows the cross-section of the dam. The roadway upon the crest was built as a substitute for a county road submerged in the reservoir, and was a considerable improvement upon its predecessor.

The dam was built upon the ground of the swamp, prepared merely by stripping off the top soil, and the earth was hauled by drag scrapers, carts, and dump wagons from borrow pits north of the reservoir, the two latter being employed for the longer hauls. Inasmuch as the excavations for some of the concrete work showed that the bottom land had a surface layer 10 ft. thick of excellent brick clay, no difficulty arose as to suitable material. The fill was rolled in layers 6 to 8 ins. thick, mainly by a traction engine weighing about five tons. While the narrow tread of the wheels necessitated much more rolling than would have been required by the use of the usual steam roller, the superior flexibility of this machine offered some advantages and the results were satisfactory. The specification requirement of 300 lbs. weight per in. of width of wheels was fairly well met.

As will be seen by reference to Fig. 2, the dam was faced with concrete on the upstream side up to a level of 6 ins. above the ordinary water level, the facing being hooked down into the soil at its edges. The permeability of the dam was thereby diminished, the saturation line under ordinary stages being kept very low, and in addition and of more importance the operations of burrowing animals were checked. This facing was built in alternate panels 10 ft. long, to allow expansion and contraction, the remaining panels being built in as soon as the first ones had set.

The surface of the dam was dressed with a layer of the top soil stripped from the site and from the borrow pits. This soil although high in organic matter was fertilized and seeded, in order to give the surface, as soon as possible, the benefit of a heavy growth of grass for protection against wash when the water level should be above the facing.

FIG. 4. VIEW OF OUTLET WEIR.

It being necessary to provide a substitute for a county road submerged by the reservoir, a road was built upon the top of the dam of section shown in Fig. 2, which road presents some novel features. Some gravel underlying the clay was excavated by steam shovel from the largest borrow pit and hauled upon the dam. This gravel with a piping system indicated upon Fig. 2 affords good drainage for the body of the road. Catch basins were also built 200 ft. apart on both sides of the road. The wearing surface was made of crushed hard sandstone, supplied from a neighboring quarry and of the same size used for concrete aggregate, viz., 2¼ to ¼-in. A surface layer of screenings was also used for binder. Some difficulty was experienced in building this road on account of the coldness of the weather, all of the work being done in December and January. The gravel as hauled was too wet to roll and it was necessary to allow the frost and air to dry it. It was then rolled on warm days when it had thawed out. The surface of screenings likewise had to be sprinkled and rolled also on comparatively warm and sunny days, a proceeding which necessarily lengthened the work. However, a road was obtained which has satisfactorily withstood the traffic up to this time and from indications will continue to do so.

Dike.

As before stated, the western side of the reservoir was formed by an earth dike 8,000 ft. long. This dike was 10 ft. wide on top with slopes of 1 on 2, and was built upon the east side of the canal embankment referred

to above. It was built similarly to the dam, with a surface of top soil, and with the foot of its slope protected with gravel instead of concrete.

The crest of the dike was built 2 ft. lower than that of the dam across the southern end of the reservoir. In case then that such an unprecedented flood should arise as to overtop the dike, the water could not pass the dam, but would escape to the Susquehanna over some low-lying ground near the north end of the reservoir. Thus in no event could any flood from the creek pass the dam.

The earth for this fill was nearly all hauled upon the ground by dinkey trains, the track being laid upon the old bank and the earth being dropped from side dumping cars, and spread in layers 6 to 8 ins. thick by a gang of laborers averaging about twenty in number. After spreading it was rolled mainly by a 10-ton grooved roller of the usual type. The bulk of the earth was excavated by a steam shovel from a large borrow pit at the north end of the reservoir, the average haul thus being about half a mile.

FIG. 5. NEAR VIEW OF DAM ON PAXTON CREEK FLOOD CONTROLLING WORKS, HARRISBURG, PA.

Weir Construction.

As stated before, three of the weirs were to be set at the same level and one, the flood outlet weir or spillway 0.2-ft. higher than the others. To fix elevations at the sites of the weirs, lines of check levels were run with an ordinary Wye-level and target rods, the readings being taken to thousandths. Benches were set at average intervals of 2,000 ft. and differences of level between benches were required to be checked within 0.01-ft. This work proved to be sufficiently accurate for the purposes of the construction.

The weirs in general consist of a paving of 6-in. thickness of reinforced concrete faced with 1:1 mortar, the earth being shaped previously with such concrete work carried ahead as was necessary to hold the earth in position. The forms were checked with a level just before concreting. The arrangement of posts and railing, a of reinforced concrete, around this weir was designed prevent brush and other obstructions from passing i the conduits and also to break up ice.

A conduit passes under the dam to an outlet weir. Th conduit has a rectangular section of 22 sq. ft. area a is reinforced transversely only with twisted steel ro The specifications required that the excavation for th conduit should be made without shoring, in order th no undetected cracks might develop back of the c through which leakage might occur when the reservo was full.

The outlet of the conduit is shown in Figs. 4 and 7. Wat flows into the chamber from the conduit and spills ov the edge of the weir, dropping upon a concrete pavin which continuously encircles the outlet. The crest of th two weirs of the regulating works are at such levels th with the resistance due to the square-edged entran and the friction in the conduit, the effective head wi only be able to compel a discharge at a maximum ra of 300 sec.-ft. This involves a velocity in the condu of about 14 cu. ft. per sec. It will be observed that th weir is constructed with a sloping approach, as are a of the weirs, and that the discharge somewhat resemble that of a fountain.

The inlet and outlet weir with their connecting conduit constitute the controlling works by means of which th ordinary flow of the creek is allowed to pass into its regular channel, diminished only by the seepage and evaporation losses in the reservoir. At the same tim no more than the limited quantity can pass through in time of flood. As to the losses mentioned; the nature of the bottom is such that seepage is comparatively nil; and should evaporation be so high in midsummer as objectionably to diminish the discharge down the creek, a gate is provided in the inlet weir by means of which the reservoir can be drawn upon, and if need be, almost completely emptied.

When the excavation for the outlet weir had been carried down to the required depth there was found a fine grained sandy clay with several springs in it which under the feet of the laborers speedily assumed the consistency of soft mush. The springs were connected with drain pipes to the pump, and the pump kept going continuously for a week. At the end of this time, a little scraping left the bottom firm and in suitable condition for the concrete work to be placed upon it.

The circular weir at the north end of the reservoir detailed in Fig. 6 differed only from the others in its shape and in the cross beams or props with which it was supplied. Placed at the receiving end of the flood outlet conduit, it was designed with great length of weir edge, so that the maximum capacity of the conduit could be reached with a comparatively low head on the weir. The sides of the spillway were of uniform thickness, reinforced vertically with rods and longitudinally in the plane of the

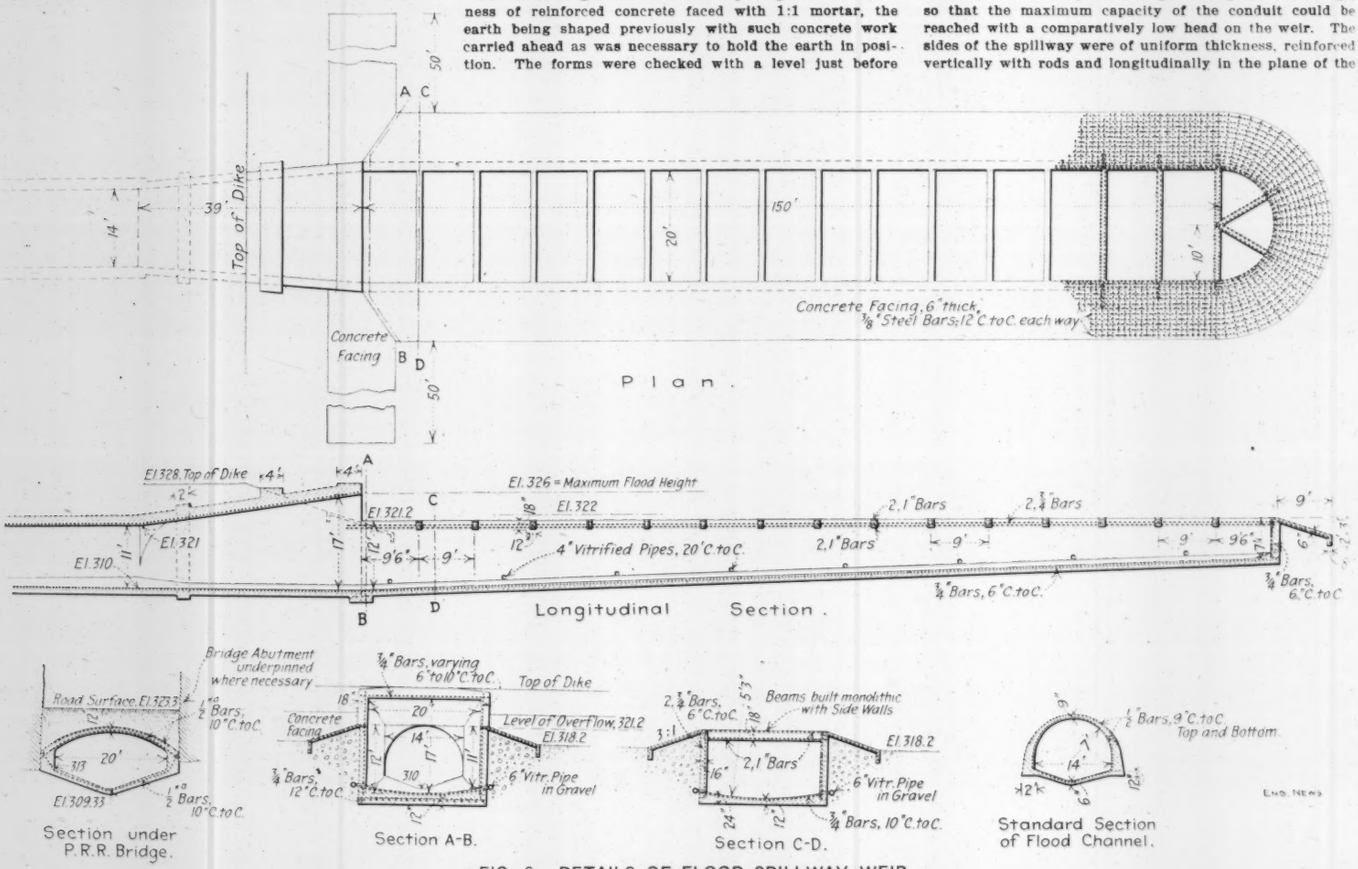
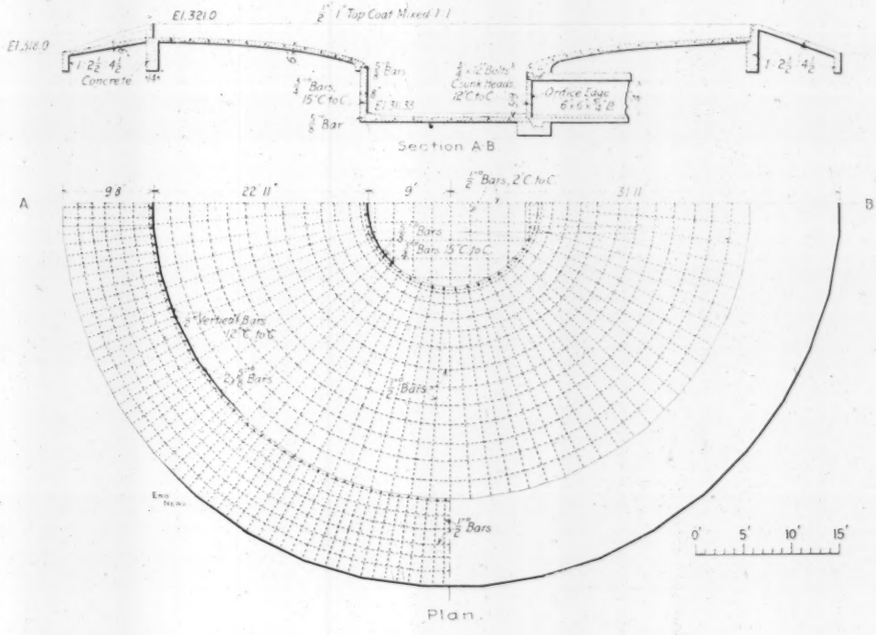


FIG. 6. DETAILS OF FLOOD SPILLWAY WEIR.

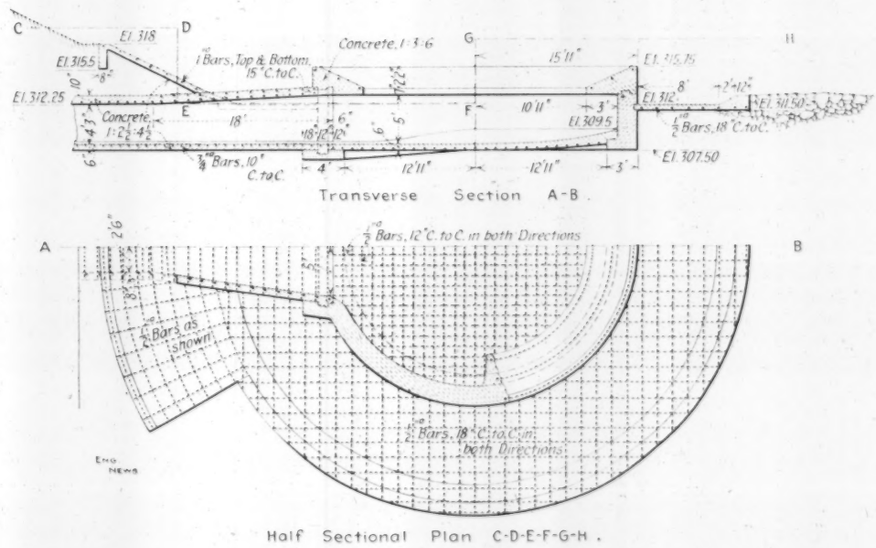
cross beams. These beams were built monolithically with the side walls and were reinforced with four rods placed in the corners. In common with some other of the concrete work, these beams and walls were built in December with no other precaution than heating the materials and covering the work with straw. The work resulted satisfactorily.

An interesting feature of the spillway was the arrangement for relieving water pressure upon the side walls. At the bottom of and behind the walls a 6-in. vitrified pipe was laid in gravel with open joints. This pipe was connected at intervals of 15 ft. with the interior of the through gravel and the bottom of the conduit was practically on bed rock. But little ground water was encountered and this was effectually carried off through a sub-drain to the mouth of the conduit and discharged into the river, which during almost all of the entire work remained accommodatingly low.

The only great difficulty encountered lay in carrying the conduit under the main line of the Pennsylvania R. R. The conduit was to be placed under the surface of a highway passing under the railroad. Its section was changed here, being made wider and lower, but the grade was necessarily such that the bottom of the side walls



A. Intake.



B. Discharge.

FIG. 7. DETAILS OF OUTLET WEIR CONSTRUCTION SHOWN IN FIG. 4.

chamber. The accumulation of water behind the wall was thus prevented and the buoyant effect of unrelieved water pressure upon the chamber eliminated.

Flood Conduit.

Most of the concrete work was embraced in the construction of the flood conduit heading from the spillway to the outfall into the Susquehanna. Fig. 6 shows the shape of the typical section and the method of construction. The conduit was 14 ft. wide and 11 ft. high, inside dimensions, the bottom reinforced transversely by a single layer of rods and the top by an inner and outer layer. Both invert and arch were built in alternate sections.

The excavation for the conduit was mainly done with a steam shovel making two cuts. As shown, no shoring was necessary although most of the excavation was came below the bottom of the masonry bridge pier foundations by two to five feet. To have held these walls by shoring would have filled the excavation so full of lumber that no work could be done. To meet the danger of settlement, alternate pits 5 ft. long were opened for the sidewalls, and a columnar space excavated to full depth under the masonry at each pit. These were then concreted, and after they had set, the intermediate pits were opened and concreted. The tops of these walls were built with an inclined surface after the manner of skewbacks. After about 75 ft. of wall had been built on each side, an arch form was built between the skewbacks and the roof concreted, which acted as a continuous prop holding the side walls. After this had set the earth below the springing line was taken out and the invert put in. Level readings had been taken upon the masonry at intervals, and no appreciable settlement noted; and there was not the slightest interference with the railroad traffic.

Cost of Work.

The contract prices for this work may be of interest and the most important of them are herewith appended. The writer's opinion is that the prices for embankment and grubbing were rather too low, the others being ample.

Cost of clearing and burning, per acre	$10.00
Cost of clearing and grubbing, per acre	75.00
Cost of top soil excavation, including replacement upon embankments, per cu. yd.	.60
Cost of excavated earth placed in embankment, per cu. yd.	.45
Cost of excavated earth wasted, per cu. yd.	.50
Cost of rock excavated, per cu. yd.	2.00
Cost of steel reinforcement, in place, per ton	59.00
Cost of concrete, Class B, in forms, per cu. yd.	7.50
Cost of concrete, Class C, without forms but covered with surface of 1:1 mortar, per cu. yd.	8.25

The quantities were such as to bring the total cost of the work, including engineering and inspection, to about $110,000.

The concrete for all work at the dam was hand mixed, as was that for most of the invert of the conduit and for the side walls of the spillway and conduit under the railroad. The rest was mixed in machines. Both methods produced satisfactory work.

Cement cost $1.55 per bbl., delivered on siding at the work, crushed stone about $1 a ton and sand 90 cts. per ton, the price varying with the haul and source of supply. The sand was taken from the river and was of only a fair quality, containing considerable fine coal. The bulk of the concrete work was of Classes B and C, of proportion 1:2½:4½.

The work was done under the direction of James H. Fuertes, Consulting Engineer, and George H. Maurice, Principal Assistant Engineer of the Board of Public Works, the writer being Resident Engineer in charge of construction. The Ferro-Concrete Company, of Harrisburg, John F. Whittaker, Superintendent, were the contractors. To Mr. Fuertes the writer is indebted for valuable suggestions in the preparation of this paper.

The Governor Reynolds Reinforced-Concrete Bridge, Province of Albay, Philippine Islands.

By OLIVER D. FILLEY.*

The three great hemp highways of the Province of Albay form a nearly equilateral triangle about the active volcano of Mayon. These roads in the order of their importance are the Legaspi-Ligae, the Ligae-Tabaco and the Tabaco-Legaspi, and serve to carry the entire hemp output of this province to the ports of Legaspi and of Tabaco. The main road, the Legaspi-Ligae, was originally, under the Spanish rêgime, a paved highway of the Roman type and the 77 bridges between Legaspi and Ligae were of cut stone masonry of the best Spanish construction. The heavy pavement was well suited to resist the erosion of the tropical rains and the heavy wear under the large two-wheeled carts used to this day in the hemp traffic.

This highway was so neglected during the Insurrection as to be seriously damaged and under the heavy military duty, together with the hemp traffic, the large paving stones were displaced and the road so badly rutted as to be impassable in places. Later under peace conditions, the ancient pavement was removed, broken by hand and replaced as a macadam surfacing and is doing duty at present under the *caminere* system of maintenance.

The bridges were massive, with exceptional depth of keystone and with spandrel fill of rubble masonry in many cases. These structures, spanning streams on the watershed of the barren western slopes of the volcano, are subjected at times to the excessive floods and to the frequent earthquakes of that region, yet with few exceptions, they exist in excellent condition today. The eruption of 1812 worked damage to the road and bridges and buried the city of Daraga with a heavy loss of life. Further damage was suffered from this source in 1864 and again in 1898.

The highway appears to have crossed the main river, the Banao, by means of the intermittent use of a ford until as late as 1855, when a massive structure over 2,000 ft., in length and 47 ft., in width was commenced under forced labor by the local governor, a well-known Spanish engineer.

*Supervising Engineer, Bureau of Public Works, Manila, P. I.

This structure was of cut basalt, obtained from the adjacent slopes of the volcano and of very heavy design. The approaches were great walls in parallel lines, buttressed within and without and filled with earth. A series of semi-circular arches fortified with masonry spandrels, spanned the river bed. The roadway over spandrels and approaches was of gravel concrete using lime mortar, and the raised sidewalks were of squared stone with conical cut protecting posts on the gutter line. The balustrade was of ornamental design and each stone of its coping was finely cut to interlock with a dovetail joint into the adjoining block. The details of drainage were worked out with equal care, the roadway being made impervious and the surface water being led away at frequent intervals and discharged through projecting stone spouts.

The piers were about 20 ft. in thickness and over 70 ft. in length with a well-rounded nose and heel as shown by the excavation within the caissons sunk for the present structure. The foundations were slightly spread but shallow, about four feet of river bed having been excavated.

This bridge was opened to the awaiting hemp carts in 1862 with a feast and celebration covering several days. The accruing benefits of this work to the Province were great, the ford having been at times impassable owing to the rains and always deficient owing to the steep banks. But in spite of the great labor expended and the apparent permanency of the work, a cataclysm in the form of a combined eruption of the volcano with a severe earthquake and flood less than two years later demolished the bridge proper and part of the approaches, in all about 300 ft. of the structure over the stream bed. Hundreds of yards of the masonry were carried far down stream by the force of the torrent.

The old ford with its difficulties was immediately reopened and the impeded traffic was taking this course upon the occupation of the Province by the Americans in 1898.

The great need of a bridge at this point was first felt by the military but owing to the cost of a permanent structure under the conditions nothing further than improving the road near the ford was done by them. The notice of the following provincial government was early called to this necessity in improving the traffic conditions at Banao, then a most serious factor in the cost of hemp transportation and in 1907 the energetic American Governor, for whom the bridge was later named, after efforts covering several years, obtained sufficient funds to warrant the Bureau of Public Works undertaking the project.

The new plans called for a structure of sufficient strength and elasticity to withstand the destructive conditions possible at this location, to be of reinforced concrete and to be so placed as to utilize the old approaches.

The accumulation of over 40 years of tropical vegetation had buried the old approaches and the remains of the broken and overturned piers. The removal of this mass of vegetation disclosed the magnitude of the wreck and the evidence of the terrific forces at work at the time of its destruction. Parts of excellent masonry were shattered across joints and through the stone as though by the action of an explosive. Masses weighing several tons were found at considerable distances.

Measurements of segments of arches and portions of lines served to reconstruct a plan showing the original lines which, when compared with the exposed wreckage, indicated the manner in which the failure had occurred and the probable location of the maximum stresses induced by the seismic disturbances—data essential in attempting a design to resist the possible future action of similar forces. A summary of this study indicated the need of exceptional surplus strength and elasticity at the crown of the arch and, surplus strength at the springing points; the general design to be along lines giving the greatest possible waterway and clearance with all practicable lightness in suspended parts; and, massive foundations to be so spread as to reduce the unit pressure on subfoundations to as low a point as possible, thus lessening the tendency to settlement under vibration and oscillation. All other details were covered by the general specifications used on current Philippine bridge work.

The new bridge is shown in the accompanyign half-tone. It has two spans of 83 ft., each with a rise of 25 ft. The width of the arch ring is 20 ft., and the roadway is 18 ft. wide clear between curbs. The length of the bridge proper is 240 ft. and the total length including approaches, 1,262 ft. From bed of the river to the roadway crown is approximately 40 ft.

The profile of the river bed and its structure as determined by borings and excavations were such as to indicate a center pier and two spans. The waterway was calculated from stream measurements and flood data. Lightness and elasticity and maximum waterway were obtained by the use of secondary arches supported on secondary piers resting on the main arches. Lightness was also obtained by keeping the spandrel fill a minimum by placing the crown of primary and secondary arches as high as practicable and in using a light coping and balustrade.

The stresses in the approximate design were determined by the analytic method and again by graphic statics. The approximate design was thereupon redesigned and recomputed in several trials until all the requirements of the special conditions under consideration and of current practice were satisfied.

The reinforcement in the foundations is steel rails framed, and in the superstructure corrugated steel continued from foundation base to the coping and rail, 40 ft. above. Both the intrados and extrados lines of the main arches are reinforced and this steel anchored in the foundation steelwork of abutments and pier. The amount of steel in the extradosal and intradosal lines is varied from springing point to crown in direct proportion to the stresses, an excess being supplied the crown and springing points for reasons before noted. Shear bars are placed at intervals. The vertical reinforcing of the secondary piers locks with the intrados bars of the primary arches and with the horizontal bars of the secondary arches.

The intrados curve of the secondary arches is an arc of a circle. The extrados curve is a horizontal line allowing 12 ins. of concrete for crown thickness. The reinforcing of the secondary arches is horizontal, continuous from abutment to abutment, and locks with the intradosal line of steel in the primary arches and is anchored in the approaches thus supplying surplus strength for cantilever action in the primary arches. Continuous horizontal lines of steel from abutment to abutment also occur in the rail, in the coping, and in the spandrel walls and are anchored in the massive masonry of the approaches. Transverse bars are placed at frequent intervals in both sets of arches.

Through necessity, construction was continued through one rainy season. The primary arches were completed before this period, all centering and falsework removed from the river bed, and construction then continued from the primary arches as a base.

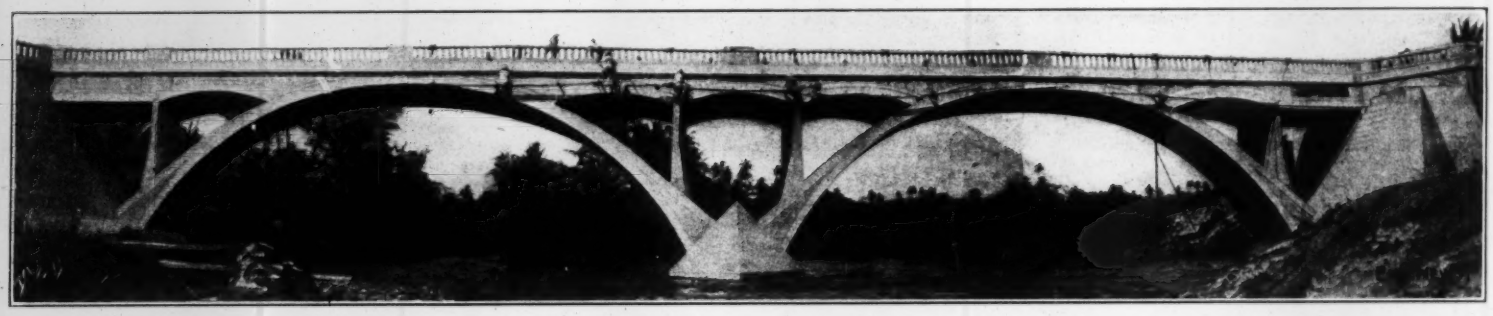
The primary arches being designed stable with the entire load of the superstructure, relatively high bending stresses were temporarily introduced in the main arch rings by striking the centers without this load. Unavoidable bending stresses also occurred in these rings at various times due to eccentric loading in the concreting of secondary piers, secondary arches and spandrels. These stresses were indicated, measured and recorded by the stress diagram daily, or upon change of load, and unsafe loading of new work was carefully avoided. The several light earthquakes occurring since the beginning of the work have apparently done little harm.

Gravel and sand was procured from the bed of the river. These materials were tested for voids and used in the proportion of 1:3:6 in the foundation and 1:2½:5 in the superstructure.

The unskilled labor was entirely native Bicols, the mechanics were Tagalogs and the carpenters Japanese.

Rigorous sanitary measures ensured very favorable health conditions. Guard and police service was furnished by the neighboring municipality of Guinabatan.

The bridge was opened to traffic Feb. 1, 1909.



THE GOVERNOR REYNOLDS BRIDGE IN THE PROVINCE OF ALBAY, P. I. A REINFORCED-CONCRETE BRIDGE BUILT BY AMERICAN ENGINEERS.

A LARGE BRIDGE OVER THE MISSOURI RIVER at Kansas City, Mo., is to be built on the piers constructed about 20 years ago for a structure to be known as the Winner Bridge. The new bridge, which will carry a double-track railway line and a highway, is of unusually heavy design. Its channel spans will be 428 ft. c. to c. The trusses are about 70 ft. deep. They carry a highway floor with two electric railway tracks and two sidewalks, 72 ft. wide between curbs, in the line of the top chord and two standard-gage steam railway tracks on a deck in the line of the lower chord. As this arrangement reduces the clearance below that demanded for navigation use, a channel passage is provided as follows: One span is raised enough to bring its bottom chord up to the top line of the adjacent spans, so that the highway (upper) deck is in the usual position for a through span. The railway floor is suspended from the trusses by hangers at the panel-points, and is arranged so that it can be lifted up to a position under the highway deck. The individual hangers are connected to individual counterweights, and the connecting cables pass over drums at the corners of the span. Revolving the four drums serves to raise or lower the floor. The scheme is due to Waddell & Harrington, who also worked out the designs. Plans are completed and the work is now in the shops of the McClintic-Marshall Construction Co. Substructure work for the approach spans has already been begun. The channel spans of the bridge will be the heaviest simple spans in the country, next to those of the St. Louis Municipal Bridge now being built. They are being detailed with riveted connections and stiff members throughout, in accordance with most advanced practice.

PANAMA CANAL EXCAVATION during January totaled 2,831,929 cu. yds., a daily average of 113,277 cu. yds. for the 25 working days. The amount of concrete laid during the month was 72,995 cu. yds. and 443,399 cu. yds. of fill were placed in dams. The rainfall was only 2.12 ins., a decided drop from the 15.85 ins. in December.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
Z. P. MARUYA & CO., Ltd., TOKYO, JAPAN

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ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See "Want" Pages.

Copy for regular, or "Contract," Advertisements should be received at least ten days before publication; "For Sale" and "Situations Wanted" Advertisements by Monday, and "Proposal" and "Situations Open" Advertisements by 9 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

What are the requisites for permanence and integrity of brickwork in tall brick chimneys? We put this question because we have not been able to get a satisfactory answer by inquiry of expert builders. Sometimes, it seems, an experienced chimney builder erects a stack that proves a failure, a structural failure that is, inasmuch as the brickwork cracks after a short time, without severe exposure, and brings the whole stack into more or less ruinous condition. What causes can be responsible for such disintegration of good brick masonry? Are we to blame the brick, or the mortar, or the mason's workmanship, or the foundation, or swaying, or atmospheric or temperature action? Or must we say we do not know?

The query may be illustrated by two puzzling cases of disintegration in brick chimneys, which came up last summer. The two cases together also furnish negative replies to some of the suppositions just made.

Both stacks were only a few years old (three to six). Both were something over 150 ft. high. One was of slender, the other of rather stout proportions. Neither had been used severely; one was really never in regular service, the other had been regularly employed in ordinary non-forced boiler service.

Both stacks were built of radial perforated brick laid in cement-lime-sand mortar. The pressure intensities in the brickwork were not considered excessive, even in hurricane winds. The foundations were satisfactory, one being on concrete on undisturbed clay soil, the other on plate-girder framing between columns in a power-station. One of the chimneys was built in summer, the other in winter. Neither showed any tilting or other evidences of integral failure, so far as we can learn.

Both chimneys exhibited slow but progressive multiple cracking, partly vertical, partly diagonal. The upper sections of both seemed to be most affected. Both deteriorated so much that they were taken down (one was felled bodily, see our issue of Aug. 19, 1909). Both had to be rebuilt, in short.

What was at fault?

We are also induced to raise the question because of a paper read last fall at Copenhagen before the International Association for Testing Materials. A Dutch professor there set forth the theory that great numbers of failures in brick and stone masonry arise from wrong mortar mixtures. He inveighed specially against cement-lime mortars, claiming them to be destructive agents by action of (1) solution, (2) percolation into the stone or brick, and (3) recrystallization. No actions of the kind he speaks of have yet been reported in this country, so far as we know. But the theory is convenient to explain just such failures as the two above noted. What bearing, if any, has the theory on these cases, and for what reasons? We commend this as well as the earlier question to the attention of engineers who deal much with brickwork.

For some years past, a considerable number of American cities have shown very marked reduction in deaths from typhoid fever. There has been a tendency among engineers and sanitarians to credit this reduction almost wholly to improvements in municipal sanitation. While such improvements have undoubtedly had very much to do with the reduction in most if not all of the cities, it should be remembered that no little credit may be due to increased skill on the part of medical attendants and nurses. Another thing that should be considered is the relation of deaths to total cases, or the mortality percentage. This phase of the subject has been brought to our attention by a letter in the New York "Medical Record" from Dr. Simon Baruch. We quote some figures given by Dr. Baruch for New York City before and after consolidation:

Typhoid Fever—Old City of N.Y., Manhattan and Bronx.				Present City, Greater N.Y.			
Year.	Cases.	Deaths.	Mort., %.	Year.	Cases.	Deaths.	Mort., %.
1890 ..	1,100	352	22	1898..	2,226	676	30
1891 ..	1,342	384	21	1899..	1,950	546	28
1892 ..	1,140	400	30	1900..	2,658	718	27
1893 ..	1,008	381	37	1901..	2,748	727	26
1894 ..	792	326	40	1902..	3,871	764	18
1895 ..	965	322	33	1903..	3,671	653	17
1896 ..	1,002	297	29	1904..	3,412	661	16
1897 ..	1,004	299	29	1905..	4,326	649	15
				1906..	3,467	639	18
				1907..	4,428	740	16
				1908..	3,058	536	17

It will be noted that the mortality from 1890 to 1897 ranged from 21 to 40% and varied considerably from year to year. It was highest in 1894. From 1898 to 1908 there has been a continuous decline, extending from 30 to 17%. Dr. Baruch says:

> These figures indicate clearly that while there is still much room for betterment there has been a sudden and decided fall in the mortality of typhoid fever in New York City since 1901.

He then proceeds to try to account for this decline of mortality percentage, but as what he has to say relates wholly to methods of medical treatment, and particularly to a system of cold bathing which he advocates, it is unnecessary to discuss here his reasons for the decline. What we do wish to urge upon the attention of our readers is the growing necessity for taking into account number of cases as well as number of deaths, in attempting to show the relation between the prevalence of typhoid and improvements in municipal sanitation.

Imagine the consternation that would be created among the faithful followers of party machines if one of our state legislatures should pass an act providing that no appointment to an important municipal executive office should be made without advertising for applicants for the position. Although no such legislation exists in England, so far as we know, there seems to be an unwritten law to that effect in many cities. In a recent number of the "Local Government Officer and Contractor," a journal published in London, we find the following advertisements for various grades of municipal engineers:

A CITY ENGINEER AND TOWN SURVEYOR is required by the Corporation of Newcastle-upon-Tyne. Salary, £800 per annum, rising to £1,000. Applications to reach Town Clerk, Town Hall, Newcastle-upon-Tyne, by Dec. 15. [Population (est.), 277,000.]

A BOROUGH SURVEYOR is required for the Borough of Weymouth and Melcombe Regis. Salary, £200 per annum, rising to £300. Applications, on official forms, etc. [Population, 19,831.]

A SURVEYOR'S ASSISTANT is required in the City Surveyor's Office of Winchester. Salary, 3½ guineas per week. Applications, endorsed "Assistant," stating age, qualifications and experience accompanied by copies of three recent testimonials, to be delivered to, etc. [Population, 20,299.]

A SURVEYOR, etc., is required by the Feltham Urban District Council. Salary, as Surveyor £100 per annum, rising £5 per annum to £125, and as Inspector of Nuisances £50 per annum, rising £5 per annum to £75. Applications, in the handwriting of the candidate, etc. [Population (est.), 5,900.]

A SANITARY SURVEYOR is required by the Penybont Rural District Council. Salary, £110 per annum. Applications, etc.

[Note: A pound is $4.87 and a guinea is $5.11. The populations which we have added are those given in the British Municipal Year Book for 1909. Presumably the populations are for 1901, except where it is stated that they are estimates. In every case, applications are to be made to the town clerk by a specified date.—Ed.]

A frequent provision of such advertisements as we have just quoted is that personal solicitation for the position, outside of fulfilling the requirements stated in the advertisement, will disbar applicants from consideration. It would be hard to imagine a greater contrast in methods of selecting municipal officers than is afforded by the foregoing advertisements and by the usual American practice. We do not need to say which method seems most likely to secure men fit for the work devolving upon them, nor do we need to express an opinion as to which plan seems most likely to result in deserved promotion from subordinate positions in a municipal technical department to the headship of the department, followed by a call to larger and larger cities. The traditional saying that every American boy may aspire to be President of the United States might be changed in Great Britain to run that every engineer who makes a good start in municipal work may aspire to be Chief Engineer of the London County Council or of one of the great British cities.

We have already called attention on several occasions to an innovation introduced by the Boston charter amendments which are going into effect this year. We refer to the provision that municipal appointees need not be residents of Boston hereafter. Mayor-elect Fitzgerald, who will take office early in February, has it within his power to go as far from Boston as he chooses in the selection of men for the heads of all municipal departments. He alone will choose these heads, subject to the limitations as to fitness and training and as to certification by the Civil Service Commission that were noted in our issue of Jan. 20. To what extent he will exercise this privilege remains to be seen. Of course, in a city so large as Boston, in which there are so many technically trained men of all classes, there is less need for going outside the city for department heads than would be the case in smaller municipalities.

The Improvement of the Ohio River for a 9-Ft. Navigation. Will it Pay?

> I come now to the improvement of the inland waterways. . . . . No enterprise ought to be undertaken the cost of which is not definitely ascertained and the benefit and advantage of which are not known and assured by competent engineers and other authority. When, however, a project of a definite character for the improvement of a waterway has been developed so that the plans have been drawn, the cost definitely estimated, and the traffic which will be accommodated is reasonably probable I think it is the duty of Congress to undertake the project and make provision therefor in the proper appropriation bill.
>
> One of the projects which answers the description I have given is that of introducing dams into the Ohio River from Pittsburg to Cairo, so as to maintain at all seasons of the year, by slack water, a depth of 9 ft. Upward of seven of these dams have already been constructed and six are under construction, while the total required is fifty-four. The remaining cost is known to be $63,000,000.
>
> It seems to me that in the development of our inland waterways it would be wise to begin with this particular project and carry it through as rapidly as may be. I assume from reliable information that it can be constructed economically in twelve years.—From the Special Message of the President, Hon. Wm. H. Taft, on the Conservation of Natural Resources, transmitted to Congress Jan. 14, 1910.

In the message from which the above is a quotation and at other times, President Taft has gone on record as strongly favoring the improvement of the Ohio River in accordance with plans worked out some years ago by the officers of the Corps of Engineers.

We print in this issue a paper by Mr. Thos. P. Roberts, of the U. S. Engineer Office at Pittsburg, setting forth the arguments in favor of carrying out the improvement of the Ohio River. In order to present both sides of the question,

we also print a paper by Mr. John Howe Peyton, M. Am. Soc. C. E., of Louisville, Ky., giving reasons why the expenditure on the Ohio locks and dams would be a waste of public funds. Our readers thus have both sides of the question and can judge for themselves which of the two engineers presents the sounder argument.

It seems to us, frankly, that the figures presented by Mr. Peyton ought to have the most serious attention from our statesmen at Washington before the Nation commits itself to the expenditure of $63,000,000 for completing the slack water navigation on the Ohio River. The Government engineers estimate that 12 years will be required to complete the work. Is there any certainty or even any *probability* that the Ohio River will be able to command enough traffic in 1922 to make the investment in its improvement pay? Mr. Peyton's figures absolutely prove that the river must carry vastly more tonnage than it does to-day or its improvement will be a great waste of public funds.

But our rivers are losing traffic instead of gaining it. Mr. Roberts himself admits this. And why are they losing traffic? Mr. Roberts admits that it is not because of lack of capacity in the waterways. He shows that by the use of a fleet of barges pushed by a stern-wheel towboat very economical transportation is possible on a moderate depth of water, say 8 or 9 ft. He thinks that this system of transport is capable of large development.

To us, however, it seems that the causes for the decline of river traffic are too deep seated to be remedied by any mere change of methods in water transport.

In comparing water and rail transportation, it is too often the custom to compare merely the quoted water and rail rates. These figures, however, do not represent the *whole* cost of transportation. The water rate does not contain the cost of improving and maintaining the waterway; and when this is included, as Mr. Peyton well shows, the cost by water often far exceeds the cost by rail.

The figures which Mr. Peyton quotes for the actual ton-mile rates at which railways are now hauling coal, deserve the attention and study of every engineer interested in transportation. He shows that coal is now being hauled in trainload lots at a freight rate *less than two mills per ton-mile*. Nor does this represent the ultimate economy which can be reached in railway transportation. The Mallet locomotive and the 100,000-lb. steel car are just beginning to open new possibilities of further large reductions in the cost of railway transportation.

But of much greater importance than the relative cost of hauling by rail or by water is the cost of handling at the terminals. It is this, we believe, that has been the chief cause for the transfer of traffic from the river steamboat to the railway. We do not see any way in which the water route can overcome this handicap. The waterway advocates talk of providing well-equipped terminals for river steamboats. Do they realize what such terminals would cost at a city like Cincinnati, for example, where the river varies over 50 ft. between high and low water? Suppose capitalists could be found willing to risk their money in wharves and freight handling machinery and warehouses located on the river bank, and exposed to the risk of floods and ice. The goods shipped or received by water, even with ideal terminal facilities, have still to undergo the cost of transfer to their final destination.

In contrast with this the railway car loaded with coal is delivered on a siding close to the boiler house of an industrial plant. The blow of a sledge opens the hopper-bottom and the coal drops into the bins. The car loaded with pig-iron is delivered right at the foundry stock-house. In shipping finished goods, the railway car is brought directly into the storeroom or alongside the kiln or into the heavy machinery erecting shop. The finished material is loaded and the car is ready to start on its journey and there is no transfer of its load till it reaches its final destination.

How can a waterway compete with the railway under such conditions? The fact is that the bulk of the traffic would seek the railway and would find it economy to do so even if steamboats would carry the goods for nothing. The handicap of the waterway is closely similar to the handicap of the steam railway competing for interurban passenger traffic with an electric line. People travel by the electric line in preference because it passes near their residence or place of business, and it carries them all the way to their destination, whereas to take the steam road they have a journey to and from the passenger stations at each end.

So the shipper who has a railway track alongside his factory or warehouse—and this is the rule in American industrial plants of any size—will send his goods by rail instead of by water, no matter how low the freight rate by steamboat.

Of course there is a narrow strip of territory adjacent to the river where freight can be cheaply shipped and received by water. But this territory can only furnish a limited volume of traffic. And unless the rivers can be made to carry a *very large volume of traffic*, the investment necessary to build dams and locks all along them is bound to be a losing one.

It is a favorite idea of the waterway advocates that when the waterways are "improved" we shall see high-class merchandise sent by water as well as the low-grade bulk traffic which is now practically the sole business left on the rivers. But the merchant or manufacturer shipping valuable goods wants first of all to know that the carrier to whom he entrusts them is responsible. The merchant may damn the railway in public as a conscienceless monopoly and praise the enterprise of a pioneer who is trying to establish a steamboat line. But when he ships valuable goods he will deliver them to the "conscienceless monopoly" to carry just the same because he knows that the railway is responsible for safe carriage and delivery.

For a concrete illustration we may take the great works of the General Electric Co., located at Schenectady, N. Y. The Erie Canal runs directly past the works and connects only a few miles away with the Hudson River, navigable for large steamboats to New York City. The company ships millions of dollars worth of manufactured goods to New York every year, for export and for local sale; but the shipments are made by rail and not by water, even when they have to be transferred by lighter to a steamboat at New York City. In order to ship a large generator, for example, by water, it would have to be first loaded on a car in the shop and brought out to the canal and there transferred to the canal boat. This boat would then be towed by a tug all the way to New York and would be subject to the dangers of fog, collision, grounding, etc. If the boat were wrecked, there would be much doubt as to the electric company's ability to recover from the owner of the boat; and to be safe it would have to go to the trouble of taking out marine insurance on each shipment.

These are some of the reasons why the railways have a tremendous business advantage over steamboats on any inland waterway. There are many other inherent advantages of the railways which have been well set forth in the report of the National Waterways Commission, published on p. 137 of our issue of Feb. 23, and in the report of the Board of Engineers, on the Lakes to the Gulf Deep Waterway, published in our issue of Nov. 4, 1909.

How, in view of all these facts, can a probable traffic for the Ohio River be expected sufficient to justify the expenditure proposed to be made upon it? The nation has spent many millions upon the improvement of waterways which are now practically abandoned. Is it wise to continue to spend money blindly, as it has been expended in the past? The National Waterways Commission was created with a view of studying the policy which the country should adopt with reference to expenditures on waterways. It would seem the part of wisdom to refer to that Commission the project for carrying out the Ohio River work before the Nation commits itself to an enterprise which will probably involve the less than a hundred million dollars expenditure before it is finally completed.

LETTERS TO THE EDITOR.

A Combination Folding Stadia and Level Rod.

Sir: Referring to the correspondence in your journal in the issues of Oct. 7 and 28, 1909, pp. 387 and 471, on stadia rods, I enclose herewith my own design, which I have found very useful and convenient in stadia and leveling operations, and trust its adoption will be equally suitable to others. Its advantages are:

(1) Each tenth and hundredth division of a foot is distinct from those adjoining.

(2) Each figure intersected by the horizontal wire is the one noted in the field book, and not one less, as in some rods. If, say, 0.3 is intersected on these rods 0.2 is noted and one unconsciously, at times, notes the figure intersected. I have traced more errors due to that cause than to any other.

(3) For close work the hundredths are read and for long distances the black blocks, which can be read, with two stadia wires, 2,000 ft. away, and are subdivided by the eye.

(4) When the rod is held at such a distance that the figures cannot be read, the number of feet on each section can be easily counted. Too much uniformity of design makes reading difficult for long distances.

(5) The rod is light and rigid, is 15 ft. long, the bottom length being 5.5 ft. long and 3.5 ins. broad. It can, consequently, be conveniently transported by rail, tram, or any other vehicle or public conveyance.

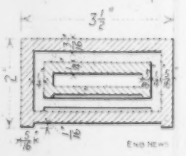
(6) When using it as a fixed rod, 10 ft. long, the first and second sections are used, without drawing out the third top or section. The first and second sections have the divisions the same size, the top one slightly narrower.

(7) It can be used both as a leveling and stadia rod.

(8) The foot numbers are marked in red or black, or they may be painted red and black alternately, the even red and the odd black.

(9) A Gurley detachable level, either circular or two at right angles, is used with it for stadia work. This is indispensable for accuracy of result, when the vertical angle is considerable.

The design of this rod will, I think, meet the exacting demands of "Suggester" for an ideal rod in your issue of Oct. 28, and requires no mental athletics to understand.



Like Prof. J. C. L. Fish, I experimented with different designs in the field and at home to ascertain the effect of distance and atmospheric vibration, and when not able to do so in the field, adopted the method of viewing them through the object end of a telescope, when a very small change of position increased the apparent distance considerably.

Portion of Face and Section Through the "Melvill" Folding Stadia and Level Rod.

In actual practice I have found that all divisions must preferably be rectangular or parallel. In wedge shaped sections the point becomes invisible, owing to halation of the white against the black and to the inability of the eye to detect an object which subtends an angle at the eye of less than 30". The inclined edge can not,

therefore, be accurately subdivided. Red divisions are not visible as far as black.

Yours faithfully,

Edward H. V. Melvill.

203 and 204 New Stock Exchange Buildings, Johannesburg, Transvaal, Nov. 28, 1909.

A Case of Long Distance Water Distribution for the Greens of a Golf Course.

Sir: It may interest your readers to know the details of a pumping plant which we lately installed that seems to us to upset some cherished beliefs about friction.

We were commissioned to water the greens of an 18-hole golf course near here, spending as little money as possible. The source of supply is a lake adjoining the links. To cover the ground with the shortest runs of pipe, none of which might cut a green, required almost exactly two miles of something. The combined talent of our office set to work to find out the cheapest something which would do the work, with results so alarming that one of us—to whom Mulvaney's advice to "beware of theoury" is as an oasis in a dry world of "facts" in which he doesn't believe—worked out a plant which we installed (under contract, at that) against the advice of the talent aforesaid—pretty good commercial talent, too.

We put in a 6-HP. single-cylinder gasoline engine, geared to a single-cylinder double-acting pump, taking water through 60 ft. of 3½-in. iron pipe from the lake 18 ft. below. The pump delivered by a 3-in. iron pipe 120 ft. long to the edge of the flat on which are the links, a vertical lift of 55 ft. The rest of the pipe system consists of 5,000 ft. of 3-in. wooden pipe in the shape of a T, the stem being 1,500 ft. long and connected to the pump by the iron pipe mentioned—iron, because it had to make a 120° bend to get over the brow of the flat. The arms of the T are approximately equal.

From the stem and arms, 18 lines of ¾-in. galvanized pipe lead to the 18 greens. The two extreme greens are supplied by ¾-in. branches from a 1¼-in. iron pipe 1,200 ft. long, run from the extreme end of one arm of the 3-in. pipe. The 18 branches aggregate just 4,000 ft. of ¾-in. pipe, and range from 100 to 500 ft. each in length. At each green is a hose-bibb, and to each bibb is attached 100 ft. of ¾-in. rubber hose, to each of which is connected a whirling lawn sprinkler.

Query: Would our 6-HP. engine, running a pump to deliver 100 gals. per min., do the work? Would there be any water at the far ends? The bets against were many, and the takers few. But on test day, she lifted the water, put it through more than 5,000 ft. of 3-in. pipe, 1,200 ft. of 1¼-in., 4,000 ft. of ¾-in., 18 angle hose-bibbs and valves, 1,800 ft. of ¾-in. hose, and 18 sprinklers (resistance unknown), and distributed from three to five gallons per minute at each sprinkler, throwing circles from 30 to 40 ft. diameter.

The only trouble we had was cured by easing the pump packing to allow a little slip, and by putting a ⅛-in. check valve on the valve-chest, to admit a little extra air. The pressure gage shows between 55 and 60 lbs. when the engine is running and everything operating.

The "boss" sits back, and wonders whether he was a daring engineer of natural, instinctive genius—or a foolhardy idiot. Be that as it may, there is clearly more basis of truth in the text-books' statement that "the laws of friction are not fully understood" than in the same books' statements as to the friction per 100 ft. in so-and-so pipe.

Wouldn't Mr. Carnegie or some other would-be public benefactor do more effectual work in reducing ignorance by some real tests of what water actually does in pipes, than by adding to the store of libraries perpetuating assumption? You cannot ascertain to-day, beyond yea or nay, how much water will come out of a pipe of any diameter, of any length, under any head, all theory and talk notwithstanding. Here is a concrete case where instinct was better than "knowledge"—and we could add a few others, but that the bubble reputation seems to shine more iridescent in the gloom of mystery. Forgive the bull, for the sake of the meat we tender. It (the meat) requires no grain of salt for digestion, though Trautwine, or Eytelwein, or Molesworth, or any such sauce will upset the system fatally.

Yours very truly,

Fuller & Manley.

Provident Bldg., Tacoma, Wash., Jan. 31, 1910.

Notes and Queries.

The inquiry of Mr. F. Lavis in Eng. News of Jan. 13, 1910, p. 51, concerning the number of shifts covered by the cost figures in the article "Some Detail Costs in Tunnel No. 7 of the Los Angeles Aqueduct," Eng. News of Nov. 18, 1909, p. 542, is answered as follows in a letter just received from Mr. C. H. Richards, the author of the article:

An eight-hour shift is composed of a definite number of men, in compliance with a schedule prepared by the office of Chief Engineer, and any arrangement of men can be made, the only requirement being that the number of men does not exceed the limit established by the schedule. During the run to which Mr. Lavis refers the miners were on the day shift, and the muckers were on at night. Ordinarily it would mean thirty 8-hr. shifts, but owing to our limitation of number of men, which was not exceeded, we call it a 15-shift run.

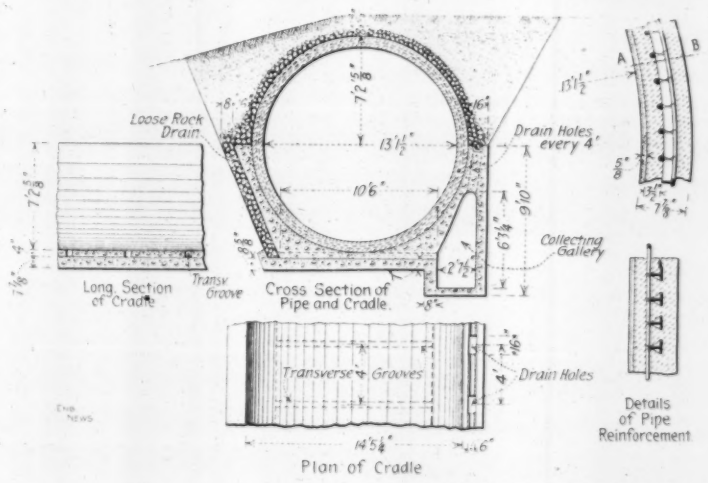
The Albelda Reinforced-Concrete Siphon for a 97-ft. Head, Tuena, Spain.*

By B. A. ETCHEVERRY.

This siphon has been very recently constructed on the same irrigation system as the reinforced-concrete siphon of Sosa and Ribabona in Spain. [Described in Engineering News, Aug. 1, 1907, p. 116.—Ed.] It is located in the province of Tuena, Spain, on the irrigation system of Aragon and Catalogne, 17 miles downstream from the Sosa Siphon. Although this siphon of Albelda is a work of less magnitude than the Sosa Siphon, it is technically much more important and interesting because of the greater pressure, larger diameter, and the absence of a steel tube to insure water tightness.

The Sosa Siphon is 3,340 ft. long, consisting of twin pipes of reinforced concrete 12.47 ft. in diameter and subject to a maximum pressure head of 85 ft. The Albelda Siphon is 2,363 ft. long and consists of a single pipe of reinforced concrete 13.12 ft. in diameter and subject to a maximum pressure head of 97 ft.

The most important difference between the two is in the design of the reinforcement. The twin pipes of the



DETAILS OF A REINFORCED-CONCRETE SIPHON UNDER 97 FT. HEAD IN THE PROVINCE OF TUENA, SPAIN.

Spacing of Reinforcement.				
Pressure in Feet.	T Bars.		Round Rods.	
	Size	Spacing	Diam.	Spacing
Up to 33	$1\frac{3}{8}" \times 1\frac{3}{8}" \times \frac{11}{64}"$	$5\frac{5}{8}"$	$\frac{5}{16}"$	4"
33 to 49	$1\frac{9}{16}" \times 1\frac{9}{16}" \times \frac{3}{16}"$	5"	$\frac{5}{16}"$	4"
49 to 66	$1\frac{25}{32}" \times 1\frac{25}{32}" \times \frac{7}{32}"$	$4\frac{3}{8}"$	$\frac{25}{64}"$	4"
66 to 82	$1\frac{15}{16}" \times 1\frac{15}{16}" \times \frac{15}{64}"$	$4\frac{3}{8}"$	$\frac{25}{64}"$	4"
82 to 98	$1\frac{15}{16}" \times 1\frac{15}{16}" \times \frac{15}{64}"$	$3\frac{5}{8}"$	$\frac{13}{32}"$	4"

Sosa Siphon consisted of 158 sections, 21.32 ft. long, joined by expansion joints. The reinforced-concrete shell was made of a steel tube about ⅛-in. thick, covered with an outside concrete layer 5.9 ins. thick, reinforced with T-bars, and an inside coat of reinforced mortar 0.81-in. thick. In the Albelda Siphon there are no expansion joints and no steel tube to insure impermeability.

The construction of this siphon was in charge of Mr. Mariano Luina, who was also engineer in charge of construction of the Sosa Siphon. Mr. Luina, with whom the writer has corresponded, has very kindly furnished the information embodied in this article.

The conduit is 2,380 ft. long between the inlet and outlet chambers and subject to a maximum pressure head of 97 ft. To empty the siphon, a channel carries the water, from the blow-off at the lowest point in the siphon, for a distance of 1,000 ft. downstream; 410 ft. of this channel is covered. The conduit proper is a single reinforced-concrete pipe 7.87 ins. thick, supported up to its horizontal diameter on a concrete cradle. As it was expected that there would be more or less leakage through the pipe, the cradle was given a peculiar shape, designed to collect the seepage water, to prevent the softening and washing away of the foundation.

This cradle is made of porous concrete and comprises a system of drains intended to collect and carry away all water percolating through the pipe and through the porous concrete of the cradle.

On the right side of the cradle is the main collecting gallery; in the upper part of this gallery drain holes 3 ft. 3 ins. deep, 16 ins. long and 6 ins. wide, spaced 4 ft. apart, connect the gallery with a longitudinal, semi-circular groove in the top of the cradle, which collects the water percolating through the upper portion of the conduit. On the left side between the outer face of the cradle and the wall of the trench, is a space of 10 ins. filled with loose rock; the lower end of this loose rock drain rests on a concrete floor and is connected to the collecting gallery by a series of transversal grooves 4 ins. wide and 3.14 ins. deep running across the concrete floor and spaced 4 ft. apart. This concrete floor slopes towards the collecting gallery and has a thickness varying from about 7 ins. at the collecting gallery to about 8⅝ ins. at the foot of the loose rock drain. To keep the grooves opened when building the cradle, each groove was covered with a metal plate 5/16-in. thick. To drain the upper half of the conduit, it is covered with an 8-in. layer of broken rock.

The concrete cradle was made of very porous concrete, so that the water percolating through the lower half of the conduit would find an easy passage into the drains. The concrete used consisted of about 1 part of cement to 4¼ of sand and 8½ parts of gravel passed through a 2¾-in. screen.

To examine the main collecting gallery, tubular openings were provided each 197 ft.

The shell of the pipe is made up of 7.28 ins. of concrete in which the reinforcement is imbedded, and of an inside plaster lining of cement mortar 0.59-in. thick, giving a total of 7.87 ins. The reinforcement consists of 124 longitudinal round rods placed about 4 ins. apart, and of circumferential bars made of T shapes and tied at their intersection to the longitudinal rods with wire about 1/16-in. diameter. Each circumferential T-bar has an exterior diameter of 14.04 ft., and is composed of two halves butt-joined together with six rivets. The reinforcing steel has an ultimate strength of 57,000 lbs. per sq. in. and its working strength was assumed at 14,200 lbs. per sq. in. The variation of the reinforcement to care for the increasing heads of water is given in the caption to the accompanying figure.

The concrete used for the conduit was a mixture of about 1 part Portland cement to 1.28 parts of sand, 2.56 parts of gravel under 1¼ ins., and 0.53 to 1.00 part of water, all by volume. The interior lining was made of equal parts of cement and coarse sand.

The interior forms were made in collapsible sections and in several parts so designed that a section could be taken apart and passed through the interior of the erected forms ahead. When completed, the upper half of the conduit was surrounded with loose rock and covered with an earth fill. The concrete work commenced on Nov. 26, 1908, and the main part of the siphon was completed on March 6, 1909. The interior lining and all accessory works were completed on April 4. The water was turned into the siphon and the conduit was tested in May.

The specifications required that the loss should be not greater than 1.32 gals. per sec., diminishing to 0.79 gal. per sec. at the end of two months. The tests showed that the total seepage loss under the full head was only 0.105 gal. per sec., or about one-twelfth of the expected loss, and this diminished to one-twenty-fourth the following days, and continued diminishing.

*From the California Journal of Technology, December, 1909, a monthly published at the University of California.

LIQUID OXYGEN.—In a lecture before the Societé des Ingineurs Civils de France in November, 1909, Mr. George Claude presented data on the production and utilization of liquid oxygen. A plant with a capacity of 50,000,000 cubic meters (1,765,000,000 cu. ft.) per annum occupies a space 20 × 30 meters (about 65 × 100 ft.). Only 15 attendants are needed. For small apparatus (capacity 1,750 cu. ft. of liquid oxygen per hour) 1 HP.-hr. is required for one cubic meter (35.3 cu. ft.) of oxygen. For larger apparatus (capacity 7,000 cu. ft. per hr.), the production is 1.25 cubic meters (44 cu. ft.) per horsepower-hour. The production is expected to rise to 1.75 cubic meters (62 cu. ft.) per horsepower-hour in the largest apparatus—projected but not built (capacity over 35,000 cu. ft. per hr.). The total cost of production (Societe de'l Air Liquide) has been guaranteed at 0.6 ct. per cubic meter of liquid oxygen (35.3 cu. ft.), including depreciation. For this figure power is secured at 0.4 ct. per HP.-hr. (as the company uses blast-furnace gas and internal combustion engines). A Belgian iron and steel company (La Societé d'Augill Marihaye) is experimenting, on a large scale with the oxygen enrichment of air for the blast of blast furnaces and Bessemer converters.

Two Foreign Developments in Railway Ties.

The tie problem is a feature in railway construction and maintenance-of-way in Europe as well as in this country, and we record below some recent experimental developments in the solution of this problem.

CONCRETE TIES MADE IN VIBRATING MOLDS.—Reinforced-concrete ties which are to be tried experimentally by the Great Northern Ry., of England, have as a special feature of their manufacture the consolidation of the concrete by vibration instead of by tamping. The steel reinforcement consists of an intricate net-

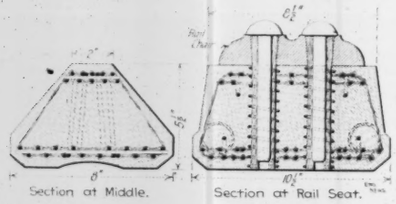
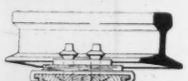


Fig. 1. Sections of Reinforced-Concrete Ties Made by the Jagger Process.
(To be tried on the Great Northern Ry., England.)

work of wires and small rods (not exceeding 3/16-in. diameter), this arrangement being considered to give greater strength and elasticity than an equivalent weight of steel in a smaller number of larger bars or rods. The reinforcement is placed in a mold which is then set on a vibrating table, and the concrete is poured into the mold. The table is said to have "a horizontal vibratory motion combined with a suddenly arrested rocking movement." The rapid shaking causes the concrete to settle as a dense mass, free from air bubbles and in close contact with all parts of the steel. The operation does not last long, and the mold is then taken from the table. When the concrete has set sufficiently, the tie is removed from the mold and allowed to cure or harden for several days. Mr. A. Ross, Chief Engineer of the Great Northern Ry. states that he has great expectations for the success of these ties.

These ties (Fig. 1) are about 9 ft. long, 5½ ins deep, with a width of 8½ ins. and 10½ ins. on top and bottom at the rail seats (20 ins. long), and 2 ins. and 8 ins. long on top and bottom at the middle and ends. The weight of steel is about 35 lbs. The concrete is made with ½-in. gravel or stone, with proportions of 1 cement to 4 aggregate, and the effect of the process is to give a smooth skin or surface. The metal rail chairs for double-head rails, or tie-plates for T-rails, are secured by round spikes or screw spikes driven into hollow wooden plugs embedded in the concrete. The report of a test made by Sir Douglas Fox & Partners (consulting engineers) as to the strength of a tie of this kind is as follows:



> The tie, four months' old, was tested as a free beam with a 60-in. span, a concentrated load being then applied on a 6-in. bearing. At 3,000 lbs. no deflection was observable; the load was gradually increased up to 7,000 lbs., when the tie had a deflection of ⅛-in. A careful examination with a powerful magnifying glass did not disclose the slightest tendency to hair cracking. The load was then removed and the tie returned to its normal position free of any set.
>
> The tie was then lifted 6 ft. and dropped horizontally on to the ground on a flat surface without the slightest damage. It was finally raised perpendicularly on one end and dropped across a timber laid transversely so as to catch the center of the tie, again without the least damage.

This method of manufacture used for these ties is known as the Jagger process, being the invention of Mr. J. P. Jagger. It is operated by the British Improved Construction Co., 47 Victoria St., London, England. The process is adapted to the manufacture of concrete blocks, piles, girders, slabs, pipes and architectural details.

COMPOUND TIES OF WOOD AND STEEL.—Among the numerous types of railway ties designed to effect an economy in the use of wood for ties is the compound or composite tie consisting of two wooden bearing blocks connected by steel members so atached as to form a complete unit or tie. Several designs of this kind have been tried experimentally, and probably the most extensive trials are those made in France during the past seven years on the Paris, Lyons & Mediterranean Ry. and the Paris Metropolitan Ry. These particular ties are the invention of Mr. Hector Michel, Civil Engineer, who has described them very fully in a paper which appears in the November number of the "Bulletin of the International Railway Congress." From this paper we abstract the following information.

The compound tie (Fig. 2) consists of two wooden blocks bolted between a pair of steel channels (with flanges outward) which are held together by transverse bars or clamps hooked over the flanges. These clamps are applied while the tie is under compression (sideways) in a special hydraulic press. The wooden blocks project above the channels, and are fitted with tie-plates; the rails are secured by screw spikes. It is claimed that the ties have ample bearing area, great resistance to lateral movement (due to the ballast between as well as outside the blocks), freedom from any liability of becoming center bound, and special convenience for thorough tamping. Other advantages claimed are longer life (due to more efficient creosoting of the smaller blocks and their compression between the channels), higher scrap value, and reduced cost of maintenance on account of the greater stiffness of the track.

For standard gage track, the steel channels are 7 ft. 3 ins. long, or 8 ft. 2 ins. if longer blocks are desired for greater bearing surface; they are commercial sections, 4⅛ ins. deep, with web 5/32-in. thick and flanges ¾-in. wide. The blocks for the 7¼-ft. ties are 2 ft. 4 ins. long; they are 7⅞ ins. or 8¼ ins. wide, and 4¾ ins. or 5⅛ ins. thick for double-head or T-rails, respectively. The clamps are 2¾ × 5/16-in. steel bars. The weight of the shorter tie complete is about 155 lbs., as compared with 177 lbs. for the wooden ties and 128 lbs. for the steel ties used by the French State Railways.

The ties can be made in various modified designs, and concrete blocks may be used instead of the wooden blocks. The information given in the paper relates mainly to tests and to the advantages claimed for the ties. It includes ex-

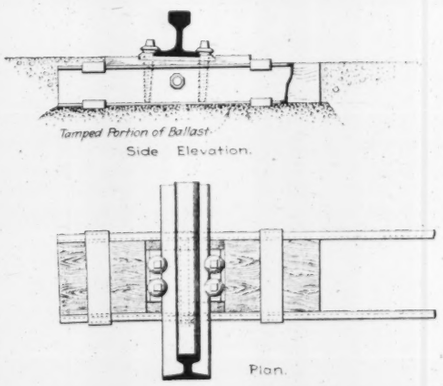


FIG. 2. THE MICHEL COMPOUND STEEL AND WOODEN TIE AS USED ON THE PARIS, LYONS & MEDITERRANEAN RY., FRANCE.

tracts from Mr. Cuenot's book on "Deformations of Railway Tracks" (Engineering News, Dec. 12, 1907, p. 661), which speaks very highly of the tie. There is no information as to the number in use, but it appears that some of those in the track have carried from 5,000 to 7,600 trains. A few ties of a somewhat similar type but put together without the heavy compression of the blocks, have been tried on the Chicago & Northwestern Ry.

The Annual Meeting of the Connecticut Society of Civil Engineers.

The twenty-sixth annual meeting of the Connecticut Society of Civil Engineers was held Feb. 8-9, 1910, at New Haven, Conn. Although the membership, as announced by the President, has increased from 286 to 297 during the past year, the attendance at this meeting was not as great as it has been at the recent four or five conventions. In addition to a luncheon and a very enjoyable banquet, at which some ninety members and guests were present, the proceedings comprised a visit to the Hammond Metallurgical Laboratory of the Sheffield Scientific School of Yale University, which was explained in a lecture by Prof. Louis D. Huntoon, two illustrated lectures and five technical papers.

The leading lecture was by Mr. H. E. Gregory, Professor of Geology, Yale University, on the "Water Resources of the Navajo Reservation, Arizona." Prof. Gregory has been commissioned by the government to investigate the whole of this arid reservation with a view of determining the amount of the water resources and the extent to which they may be utilized for the development of the region. On account of the Congressional investigation of the Interior Department now pending, Prof. Gregory was not allowed to give as full a statement as he had intended of the matter, but was forced to confine his remarks to a general description of the very interesting country and an abstract of the work he had been doing. The Navajo reservation comprises some 19,000 sq. miles in the northeast corner of the Territory of Arizona. It is a remarkably arid country with rain-falls varying between 4 and 10 ins. per year. In prehistoric days this section was the home of the famous cliff dwellers, and their rocky residences are still to be found carved out of the sides of the occasional buttes. This prehistoric race long ago disappeared, and their place is now taken in one section by the nomadic Navajo and in the other by the agricultural Hopi. From indications which can even now be found, it seems entirely probable that quite a number of the cliff dwellers lived in separate communities, although these small cities to-day are without sufficient water to support so large a population. It was the purpose of the force under Prof. Gregory to determine where the water for the original cities came from. By careful investigation, which included many miles of horse-back riding and a considerable number of borings, he found that in most districts there was a pervious stratum some few feet below the ground surface in which water could be found and through which it traveled, in fashion somewhat similar to the leaders to the artesian well, to locations adjacent, generally, to the old villages. By a careful exploration it was also found that this condition was known by the old cliff dwellers and that near most of these villages there had been dug a wide and shallow well reaching just to this layer. Strange to say, the villagers on leaving their towns at some far distant date, desired for some reason or other to conceal the presence of these wells, and in nearly every village site there was found a well, covered with boards and planks on which was replaced the original layer of dirt. In these old wells and in new ones to be bored, it is thought, is the hope of this reservation. By means of submerged dams to lead the water in the proper direction and possibly in small channels, the government considers that it will be able to furnish enough water to the district to enable the Hopis to increase their agricultural pursuits, and to provide enough water-holes for the Navajos to enlarge their sheep growing industry.

The second illustrated lecture was by Mr. Frederick L. Ford, City Engineer of Hartford, Conn., on "Eight Weeks Civic Study Abroad." Two years ago in this same meeting Mr. Ford described the city improvements which he had observed in an extended trip through the larger cities of this country. The later lecture was along the same lines of the former, but was the result of a trip made last summer through the

larger cities of England, Scotland, Holland, Belgium, France, Germany and Austria. The lecture included some 125 views of the municipal improvements in these cities, and was accompanied by running description bringing out the more important details which the speaker had observed. In general, Mr. Ford said that although the larger cities of Europe, especially Paris, Berlin and Vienna, were much superior in municipal decoration and art to those in this country, still the small cities were as a rule not in better condition than are ours, and in addition, even the great cities had certain districts which were anything but up to the standard set by the general condition of the town.

Two papers of the day were devoted to a description of dams built in the State of Connecticut in the past twenty-five years. In 1876 the State Legislature passed a law, authorizing the appointment of a Board of Engineers, whose duty it should be to supervise the construction of all water power and water-supply dams in the state. This board was to consist of the civil engineer member of the Board of Railway Commissioners and one civil engineer appointed from private practice, in each Congressional district. Under the workings of the law, anyone who intended to construct a water-retaining dam, the failure of which might endanger life and property, was ordered to present the plans to one of the members of the aforesaid board for approval, this member to be paid in fee as though it were a private consultation. The member having approved the designs or made such changes as he deemed necessary, the revised plans, signed by the member, were to be placed on record in some government office mentioned in the law. Thus, in case of any failure, the owner would be protected by this filing against the charge of negligence.

Mr. Charles E. Chandler, who wrote the paper entitled "Dams Approved By Henry F. Potter," said that the law had two doubtful points: (1) Is state approval for reconstruction necessary? and (2) Is it necessary to get state approval in small dams where potential damage is slight? The first, he said, is not necessary by a strict construction of the law, although the second is. These two conditions he thought should be reversed. Another fault of the law is that the filing made by the member of the Board does not have to be a detailed report, but only a statement that the design is acceptable. In redesigning a dam or in rebuilding a power plant, it is always most desirable that the details of construction of older structures should be known, but in the great majority of cases these details it is impossible to obtain. Therefore, Mr. Chandler thought that it would be most desirable if filings of exact details were made along with the approval by the member of the commission. To this end he presented such drawings and description as he had been able to obtain of the dams approved by Mr. Potter, who was a member of the Commission. In this same connection Mr. Nelson J. Welton presented to the Society a list of the "Dams and Reservoirs Built in Connecticut" under his supervision while a member of the Commission.

Mr. George A. Orrok, Mechanical Engineer with the New York Edison Company, described the various styles of timber and masonry bulkheads, which are generally used in and around the waters of New York. These run from the pile and timber floor retaining wall to the heavy standard concrete bulkheads of the New York Department of Docks. Most of the paper consisted of the description of detail construction, too long to be included in an account such as this.

The final paper of the day was by Mr. Benjamin L. Hinckley, Engineer of Tests, N. Y., N. H. & H. R. R. Co., entitled "Problems Handled by the Test Department of a Large Corporation." Mr. Hinckley's paper took up in succession the various materials which his department is called upon to test in the course of his daily work. Each material was discussed separately and an abstract given as to the various points to observe in making tests upon it.

The following officers were elected for the ensuing year: President, Mr. Shepard B. Palmer; 1st Vice-Pres., Mr. Charles A. Ferry; 2d Vice-Pres., Mr. A. W. Sperry. Mr. J. F. Jackson, New Haven, was continued as Secretary and Treasurer.

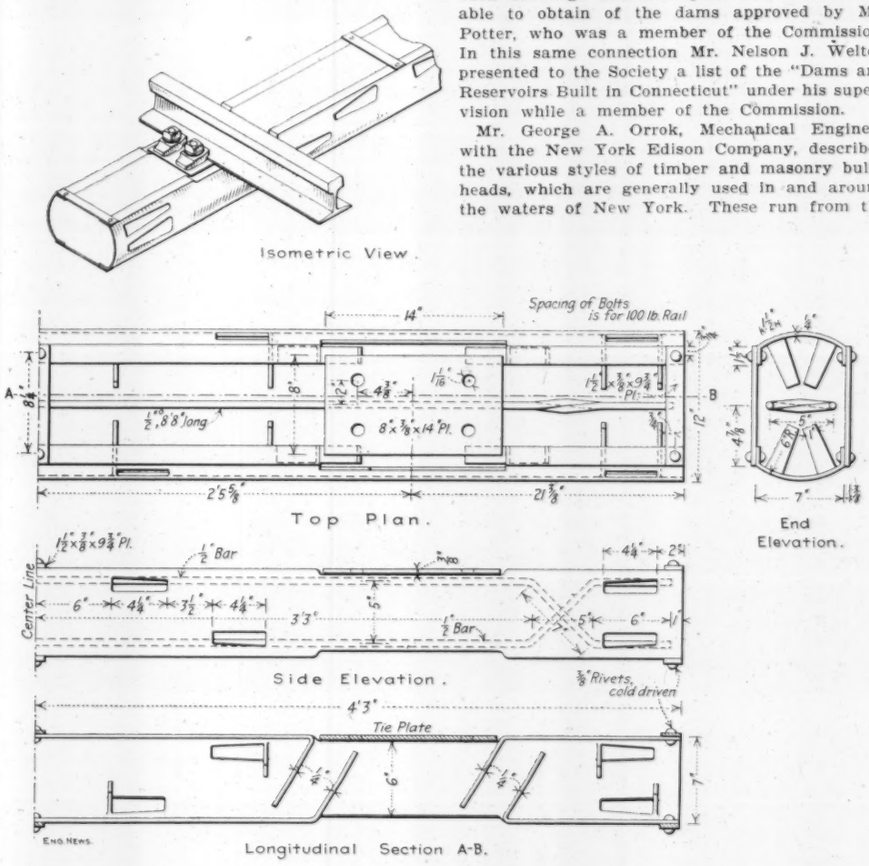


FIG. 1. THE RIEGLER CONCRETE AND STEEL TIE IN EXPERIMENTAL USE ON THE PITTSBURG, FORT WAYNE & CHICAGO RY.

A Combination Steel and Concrete Tie on the Pittsburg, Fort Wayne & Chicago Ry.

A recent type of reinforced-concrete tie now in experimental use on the Pittsburg, Fort Wayne & Chicago Ry. is giving satisfactory results from a mechanical point of view, although it is criticised by the railway on the ground of its great weight and high cost. The opinion expressed is that railways are never likely to afford such an expensive form of tie as this. The number of ties and the length of their service are too limited for definite conclusions to be drawn, but it is to be remembered that the experience with concrete ties in this country has been mainly unsatisfactory, as shown by a report published in our issue of September 30, 1909.

The construction of the tie above mentioned is shown in the accompanying cuts, and it will be seen that the concrete body is not only reinforced by two longitudinal steel rods embedded within it, but is also partially enclosed in a steel shell. On each side is a steel channel (with curved web), having slots punched to form projecting tongues which are bent inward. The flanges also are partly cut away at the middle and bent inward. Thus all the projecting parts are embedded in the concrete. The channels are connected by transverse straps riveted to the flanges, so that in all there is a considerable amount of work involved in the manufacture of each individual tie.

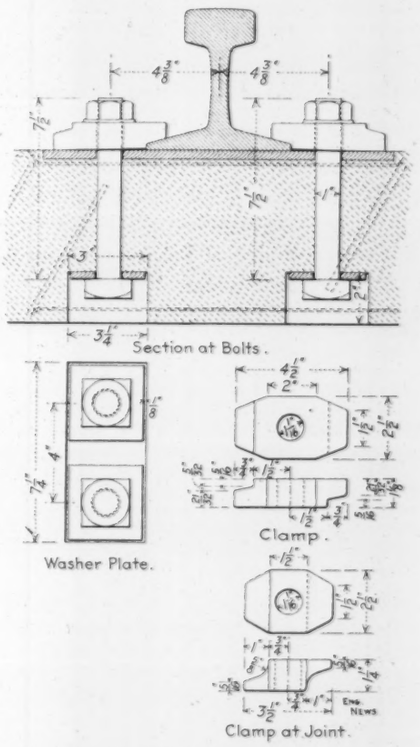


Fig. 2. Rail Fastenings for the Riegler Concrete and Steel Tie.

The fastenings are notable for the use of bolts; the heads lie in pockets in the bottom of the tie, and the nuts are screwed down upon clamps which hold the base of the rail. There are four bolts to each rail. The rails rest upon metal plates which are in contact only with the concrete, the flanges of the side channels being cut away at these points in order to prevent metallic contact from causing trouble where a track circuit is used for the signaling system.

The ties have a large bearing surface, and 15 are used to a 33-ft. rail length instead of 18 wooden ties as used elsewhere in the same track. It is claimed that the rounded sides assist in spreading the downward thrust to a short distance on each side of the tie; and that the reaction assists in holding the tie from slewing.

all the ties remaining in their original position at right angles to the track. The weight of the complete tie is 800 to 850 lbs. (the ¼-in. steel shell weighing 150 lbs.), but the inventor states that experienced trackmen will have little difficulty in placing the ties. It is proposed to cast a ring in the end, to which a short piece of rope can be attached for hauling the tie into place.

There are 15 of these ties in use carrying a 33-ft. rail length of track in the westbound main passenger track of the Pittsburg, Fort Wayne & Chicago Ry. west of Emsworth, Pa. This track carries through and suburban trains and a number of freight trains daily. The ties were laid in May, 1908. At the inspection in September, 1909, they were found to be in good condition. The bolts were tight, with the exception of one, the nut on which could not be tightened on account of the bolt turning in the tie. The section foreman stated that he had not found it necessary to tighten the bolts for a period of five months previous to this inspection. He stated also that the ties require about the same amount of surfacing as the wooden ties in the same track, but that they hold in line better than the wooden ties. The insulation is thoroughly satisfactory, and there has been no trouble with the track circuit used in connection with the automatic signals. At the same time, the engineers of maintenance of way consider that the tie is too heavy and too costly.

The tie is the invention of Mr. L. J. Riegler, of Pittsburg, an assistant in the maintenance-of-way department, and has been patented by him. For information and drawings we are indebted to the inventor and to Mr. R. Trimble, M. Am. Soc. C. E., Chief Engineer of Maintenance of Way of the Pennsylvania Lines (Northwest System).

A Covered Bridge of Reinforced Concrete, Southbridge, Mass.

The American Optical Company, Southbridge, Mass., in expanding across the small river on which it is located deemed it desirable to remove the power generation far away from the present site, so that the distance between the new power-house and the nearest aisle of the old plant is now 1,200 ft. Among the new buildings involved in the extension of the factory are the power-house, a large manufacturing building, a tunnel under the new factory building to the power-house, and a covered bridge serving as the continuation of the tunnel. All of these buildings are constructed in reinforced concrete, using the Kahn system of reinforcement throughout.

There are many features deserving the interest of the building engineer in all of these buildings: the bridge, however, is particularly interesting. A reinforced-concrete tunnel of about 1,000 ft. long, built in open trench, leads from the power-house towards the old factory, terminating at the river opposite the factory at the height of the second floor. The bridge runs from this portal across the river into the second floor of the old building. Structural steel trusses first were intended to carry the many wires and pipes for power and heating, and although they would have done well as far as strength is concerned, the owners laid much stress upon a sightly appearance, consistent with the general architecture of the factory. This, together with considerations regarding the ease of mounting and insulating the conduits, led to the adoption of reinforced concrete. As built it proved to be cheaper than a steel construction lined with a fireproof box.

Since the bridge is to be used for a pipe gallery it differs considerably from ordinary bridges in that it is in box section and carries its load

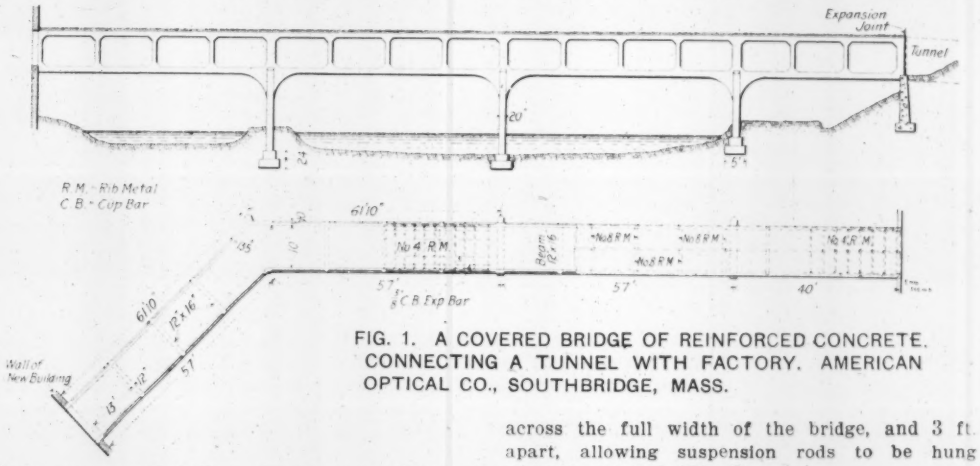


FIG. 1. A COVERED BRIDGE OF REINFORCED CONCRETE. CONNECTING A TUNNEL WITH FACTORY. AMERICAN OPTICAL CO., SOUTHBRIDGE, MASS.

both on top and bottom chords, or as they are built, slabs. As shown in Fig. 2 it connects the portal of the tunnel on one bank of the river with the factory on the other bank. It has one 40 ft. and two 57 ft. spans in line of the tunnel and one 57 ft. span on an angle of 55° with that line, running into the factory. The piers and abutments are of reinforced concrete resting on spread footings to a gravel bottom, and to them the bridge is solidly connected, making a continuous structure from abutment to abutment.

The side walls of the box section are designed as 6 × 96-in. reinforced-concrete girders, strengthened at regular intervals with 10-in. posts, reinforced as columns. The bottom and top flanges of the girders are also widened to 10 ins. and provided with extra reinforcement. Connecting the base of each pair of opposite strengthening posts is a 16-in. floorbeam and across the full width of the bridge, and 3 ft. apart, allowing suspension rods to be hung wherever desired (Fig. 3).

On this beam is placed the 6-in. floor slab. The roof slab is not strengthened with cross beams but consists merely of a 6-in. slab. Continuity is ensured both by the disposition of the reinforcement and by the curved brackets at each pier.

To facilitate the mounting of pipes and wires, shaft-hanger inserts were put into the ceiling

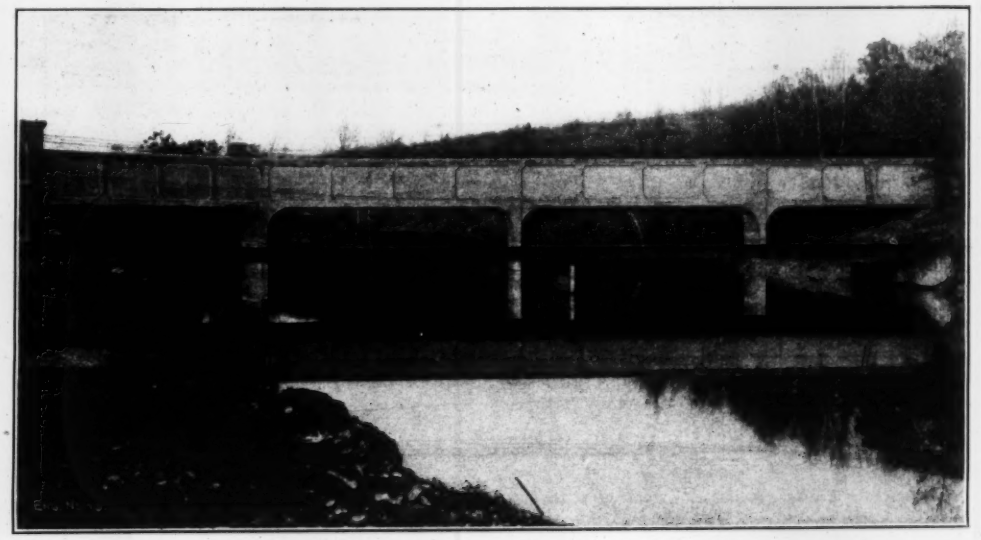


FIG. 2. PLAN AND ELEVATION OF COVERED BRIDGE.

The reinforcement is given in detail on the drawings, Figs. 2-3. It consists of the familiar pronged Kahn bars in the cross beams and in the flanges of the side girders, "Cup Bars" for the auxiliary reinforcement of the side girders and for the expansion reinforcement of the slabs, and sheets of "Rib Metal" (i. e., ribs rigidly connected by small cross members) for the webs of the side girders and for the main reinforcement of the slabs. The design assumed a load of 50 lbs. per sq. ft. on the roof, both from snow and from interior hanging load, and 100 lbs. per sq. ft. on the floor.

The bridge was designed by the engineering department of the Trussed Concrete Co., Detroit, Mich., and built by the construction department of the American Optical Co.

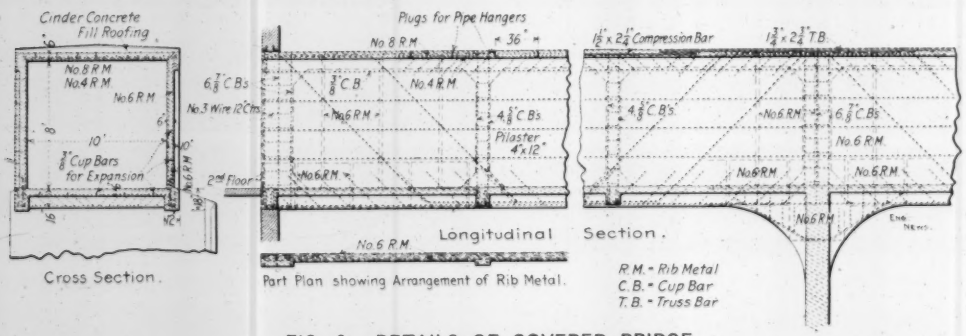


FIG. 3. DETAILS OF COVERED BRIDGE.

Annual Meeting of the Ohio Engineering Society.

(Contributed.)

The annual meeting of the Ohio Engineering Society was held at the Great Southern Hotel, Columbus, Ohio, on Feb. 8, 9 and 10, 1910. President C. J. Peters, of Tiffin, presided throughout the sessions. The attendance was large and enthusiastic, and about 30 applications for membership were favorably acted upon, making the total membership of the society about 250.

Considerable time was spent in the consideration of the proposed bill now pending in the state legislature, providing for the appointment

of a State Board of Registration and Examination for civil and mining engineers and surveyors. The society was given a hearing before the Judiciary Committee of the House of Representatives, and it is believed that this bill, for which the engineers of the state have been working for several years, has an excellent chance of favorable consideration by the legislature, and will serve to place the profession more nearly on a par with the medical and legal professions, which have been afforded similar protection by the laws of the state for many years. This class of legislation is looked upon as even more important to the public than to the profession which it nominally protects, as it must necessarily weed out the dishonest and incapable practitioners, thereby safeguarding the health, welfare and exchequer of the people.

The sessions opened on Tuesday, Feb. 8, with an address of welcome by Hon. Geo. S. Marshall, Mayor of Columbus, who referred in complimentary terms to the work of engineers employed by that city in the design and construction of the water and sewage purification plants and the garbage reduction plant now under construction.

President Peters, in his annual address, offered numerous suggestions for the betterment of the professional conditions in the state, and urged a policy of more aggressive self-assertion.

Mr. T. C. Connar, mining engineer, of Zanesville, read an original paper on the origin of weights and measures, tracing the connection between the modern units and ancient Egyptian and Hebrew standards.

Prof. John R. Chamberlin, of the Ohio State University, described at length the Cerro de Pasco Railway in South America. The road is about 80 miles in length, having a maximum curvature of 16° and approximately 2% average grade.

An interesting paper entitled "Some Principles Governing the Design of Small Sewage Purification Plants" was read by Paul Hansen, Assoc. Mem. Am. Soc. C. E., Acting Chief Engineer, Ohio State Board of Health. Mr. Hansen outlined the proper methods to be used in determining the necessary degree of purification and selecting the most desirable type of plant.

Mr. George P. Shute, of the firm of Bradbury & Shute, civil and sanitary engineers of Columbus, contributed a description of a small waterworks system installed under his supervision at Medina, O. The source of water is a gravel bed underlying the Rocky River at a distance of 2½ miles from the village, the water being collected by an open joint tile pipe and lifted to a standpipe 290 ft. above the pumps; the pumping outfit being an engine operated by producer gas. A special feature to which attention was called was the economical operation, the present operating cost being about 3½ cts. per thousand gallons.

A report upon the use of Road Preservatives and Dust Suppression Materials in Hamilton County, O., was read by Col. J. M. Harper, of the Committee on Highways. Tarvia has been used on 13½ miles of macadam roadway and asphalt oil as a dust eliminator on 45½ miles. The specifications provide for the application of from 2 to 2½ gallons of Tarvia per square yard, which was paid for at a uniform price of 25 cts. per sq. yd., including application. Roads treated 18 months ago, subjected to heavy traffic, are reported to be in as good condition as when built. The application of oil cost on an average 2.9 cts. per sq. yd.

Mr. Frank R. Lander, of Cleveland, County Surveyor of Cuyahoga County, described the extensive improvements of that county. The paper showed a total of 132 miles of brick pavements in the county aggregating in cost $2,754,724, and about 30 miles of macadam, bitulithic and asphalt pavements, bringing the total cost of road improvements up to $3,338,219; 63 miles of brick pavement are under construction, the estimated cost being about $1,478,000, and preliminary work has been done on 34 miles in addition, the cost being estimated at $676,000.

An exhaustive description of the Rocky River Bridge at Cleveland, O., was given by Mr. A. M. Felgate. The principal features of this bridge are the design of the main arch with a span of 280 ft., the method of raising the compressive strength of the concrete by the introduction of embedded stone slabs, and the arrangements for the centering used during the erection of the main arches. The bridge spans the river at a point where the banks rise about 100 ft. on each side of the water. The total length of the bridge is 708 ft., embracing the 280-ft. central span, with three 44-ft. approach spans at the west end, and two similar arches at the east end. It will carry a 40-ft. roadway with two car tracks and two 8-ft. sidewalks. The 280-ft. arch consists of a pair of plain concrete ribs, each 22 ft. wide by 11 ft. thick at the springing line, and tapering to 18 ft. in width by 6 ft. thick at the crown. These ribs have no steel reinforcement; the span is one of the longest arches of its type in the world at the present time. The horizontal thrusts from one of the ribs is 3,110 tons, and the vertical reaction is 5,450 tons.

The use of automatic siphons and air lock apparatus was described and explained in detail by Mr. E. G. Bradbury, M. Am. Soc. C. E. The various types of siphons were illustrated by charts, and remedies for defective operation were suggested.

The convention closed with a most enjoyable banquet, at which Col. J. M. Harper, of Cincinnati, acted as toastmaster.

The following officers were elected for the ensuing year: E. G. Bradbury, Columbus, O., President; John Laylin, Newark, O., Vice-President; C. J. Knisely, New Philadelphia, O., Secretary-Treasurer; J. M. Harper, Cincinnati, O., F. J. Cellarius, Dayton, O., A. F. Cole, Marietta, O., and B. E. Trask, Granville, O., Trustees.

A SAWMILL BOILER EXPLODED at Crump, Mich., 18 miles northwest of Bay City, Feb. 10. The mill was completely wrecked and six of the 25 employees were killed while five others were seriously injured.

AN EXPLOSION IN A COAL MINE at Stearns, Ky., Feb. 9 killed six men. The six victims were the only persons in that part of the mine where the explosion took place. The mine is owned by the Stearns Coal Co.

A BUTTING COLLISION NEAR MACON, GA., on the Georgia Southern & Florida Ry., Feb. 14, killed eight persons and caused the injury of 24 others. Two passenger trains collided 19 miles south of Macon. The locomotives and the baggage and express cars were demolished and the coaches were derailed. The accident is ascribed to a misreading of train orders.

A TROLLEY CAR WAS WRECKED Feb. 9 at Dalton, Mass., on the Hinsdale-Dalton Branch of the Pittsfield Electric Street Ry. At the top of a down grade one-half mile long, known as Cemetery Hill, the motorman found that the brakes had no effect on the car's speed. In spite of his efforts with both the air and hand brakes, the car descended the hill at excessive speed and left the track at a sharp curve at the bottom. Thirty feet beyond the curve, the track runs under a short bridge with stone abutments. After breaking off a pole, which somewhat checked its speed, the car crashed into the stone abutment at the left side of the track. The left side of the car was smashed and, of the 70 passengers, one was killed and 50 injured.

The Board of Aldermen, of Pittsfield, Mass., on account of this accident, ordered the suspension of operation of cars over the line where it occurred, but this order was ignored by the railway officials. On Feb. 14 the controlling interest in the Pittsfield Electric Street Ry. Co. was sold to the New York, New Haven & Hartford R. R.

TWO BAD SHIPWRECKS took place during the week. The steamer "General Chanzy," owned by the French Transatlantic Steamship Co., was wrecked Feb. 10 on a reef off Minorca Island. All but one of the 157 persons on board perished. The ship was wrecked during a heavy gale and her running onto the reef is ascribed by the steamship company to insufficient lights on the north coast of the island.

The steamship "Lima," owned by the Pacific Navigation Co., went ashore Feb. 12 on one of the islands in the Huamblin Passage of the Straits of Magellan in a dense fog and a stormy sea. In spite of the rough weather, 205 of the persons on board were rescued by the small boats of the British steamer "Hatumet," but the rescue work finally had to be discontinued with 88 persons still clinging to the stern of the wreck.

A LARGE CONTRACT for two battleships of the first order has been let to American firms by the Argentine Republic. According to press dispatches the amount involved is approximately $22,000,000 and the award was made to the Fore River Shipbuilding Co., but the New York Shipbuilding Co. is reported to have an arrangement with the former company whereby each company is to build one of the battleships. The Bethlehem Steel Co. is also concerned in the contract. This contract has been much sought after for many months by many of the large builders from England, France, Germany and the United States, and its final award to American firms is regarded as a great triumph.

THE RIVERS AND HARBORS APPROPRIATION BILL reported to the House on Feb. 11, carries cash appropriations amounting to $35,173,846, and authorizes in addition expenditures under continuing contract appropriations, amounting to $7,206,430. The House Committee on Rivers and Harbors in reporting the bill urges that hereafter River and Harbor work be provided for by the passage of annual appropriation bills. The total estimated cost still to be paid on all the projects now under improvement by the Government is $252,000,000. In addition projects have been favorably reported upon but not adopted by Congress amounting to $87,548,000. If it were decided to complete all these works in twelve years an annual appropriation bill of only $32,000,000, including the cost of maintenance, would be sufficient for the whole.

Among the notable appropriations carried by the bill are the following: $2,000,000 for the Lower Mississippi, from Cairo to the Gulf, which, added to the $2,000,000 carried by the Sundry Civil Appropriation bill, makes a total of $4,000,000. It is proposed to expend this amount annually for twenty years. For the Mississippi, from Cairo to the mouth of the Missouri, $500,000, with a view to obtaining an 8-ft. depth from Cairo to St. Louis and a 6-ft. depth from St. Louis to the mouth of the Missouri, and completing the work in 12 years. For the Upper Mississippi to St. Paul, it is proposed to spend $1,000,000 the coming year and complete the improvement to 6-ft. depth in 12 years. For the Missouri River, from Kansas City to its mouth, $1,000,000, with a view to securing a 6-ft. channel, and a Board of three officers is ordered to report on the "most economical and desirable plan of securing such a channel." For a waterway from Lockport, Ill., to the mouth of the Illinois River, $1,000,000. This appropriation is not to be available, however, until Congress shall receive the report of a Board of five engineers "upon the extent to which the United States may properly cooperate with the State of Illinois in the construction of such a channel and the development of water power thereby." The Board is also to report upon a project originated by Mr. L. E. Cooley for improving the Mississippi between the mouth of the Illinois River and Cairo by the construction of dams at Jefferson Barracks and at Commerce, and the development of water power. The President of the Board is to be Col. Wm. H. Bixby and it is to comprise three other engineer officers and one civilian engineer. The Board is to report before Nov. 1, 1910. For continuing the 9-ft. slackwater navigation project on the Ohio River, the committee recommends appropriations at the rate of $5,000,000 per annum to complete the whole work in twelve years. The present year's appropriation, however, is only $1,675,000, with authority for contracts amounting to $2,500,000 in addition.

A novel feature in the bill is an appropriation of $500,000 with which the Mississippi River Commission is to build "two experimental towboats of modern but different types, with a complement of suitable barges and necessary loading and unloading facilities, for towing and delivering supplies along the Mississippi River and its tributaries."

Personals.

Mr. Robert Hawxhurst, Jr., M. Am. Soc. C. E., is examining mines in Roumania and Bulgaria.

Mr. A. F. Harley, M. Am. Soc. C. E. and Assoc. M. Inst. C. E., will open a consulting engineering practice at Jacksonville, Fla.

Mr. Bion J. Arnold, M. Am. Soc. C. E., has been appointed Engineer in charge of construction of Chicago's proposed subway system.

Mr. Gustav Lindenthal, M. Am. Soc. C. E., of New York City, was married at Durham, N. C., Feb. 10, to Miss Carrie Herndon of that city.

Mr. W. Hamilton has been appointed Master Mechanic of the western division of the Grand Trunk Ry. at Battle Creek, Mich., succeeding Mr. E. D. Jameson, who has been assigned to other duties.

Mr. W. C. C. Mehan, Superintendent of the Grand Trunk Pacific Ry., at Melville, Sask., has been made General Superintendent of the mountain division, with headquarters at Prince Rupert, B. C.

Gen. Theodore A. Bingham, Corps of Engineers, U. S. Army, retired, recently Police Commissioner of New York City, has resumed his practice as a consulting engineer with offices at 2 Rector St., New York City.

Mr. A. Falkenau, M. Am. Soc. M. E., formerly President of the Falkenau-Sinclair Machine Co., of Philadelphia, has associated himself with Mr. Geo. K. Hooper, industrial engineer, 165 Broadway, New York City.

Mr. A. D. Parker, who resigned last summer his position as Vice-President and General Manager of the Denver & Rio Grande R. R., has become President of the Colorado Midland Ry. and Vice-President of the Colorado & Southern Ry.

Mr. W. J. Bohan has been appointed Mechanical Engineer of the Northern Pacific Ry. at St. Paul, Minn., to succeed Mr. J. E. O'Brien, who has resigned to become Superintendent of Motive Power of the Western Pacific Ry. at San Francisco, Cal.

Mr. James T. Wallis, Superintendent of Motive Power of the Pennsylvania R. R. at Williamsport, Pa., has been made Acting Superintendent of the West Jersey & Seashore R. R. to take the place of Mr. D. H. Lovell who is on leave of absence on account of ill health.

Mr. William Arthur, of Omaha, Neb., has been appointed Valuator in the buildings division of the physical valuation department of the Nebraska Railway Commission, effective March 1. Mr. W. D. Hester, of Lincoln, Neb., has been appointed Assistant Valuator under Mr. Arthur.

Mr. Elwin C. Foster, recently President of the New Orleans Railway & Light Co. and formerly Vice-President and General Manager of the subsidiary companies of the Massachusetts Electric Cos., has associated himself with Sanderson & Porter, engineers, 52 William St., New York City.

Mr. Samuel Rea, M. Am. Soc. C. E., Second Vice-President of the Pennsylvania R. R., and Mr. George S. Webster, M. Am. Soc. C. E., Chief Engineer and Surveyor of the Philadelphia Bureau of Surveys, will each be given the honorary degree of Doctor of Science by the University of Pennsylvania on Feb. 22.

Mr. J. A. Stocker, of Columbus, Ohio, has been appointed Chief Engineer of the Toledo & Ohio Central Ry. and the Zanesville & Western Ry. to succeed Clifford Buxton, M. Am. Soc. C. E., whose death was noted in our issue of Jan. 20. In his new position, Mr. Stocker's headquarters will be at Toledo, Ohio.

Mr. A. B. Stevenson has been appointed Superintendent of the Idaho division of the Oregon Short Line R. R. at Pocatello, Idaho, to succeed Mr. W. H. Jones, who has been assigned to other duties. Mr. Stevenson was formerly Superintendent of the Utah division at Salt Lake City. He will be succeeded by Mr. A. F. Brewer.

Mr. P. B. Beery, Assistant Manager of the Sandusky Portland Cement Co., Sandusky, Ohio, has severed his connection with that company after 14 years of service and has become Secretary and Treasurer in charge of sales of the Allentown Portland Cement Co., Allentown, Pa. The new plant of the Allentown company will have an initial output of 3,000 bbls. daily.

Mr. Amory Coffin, M. Am. Soc. C. E., recently Chief Engineer with the architectural firm of Geo. B. Post & Sons, Architects, and formerly Chief Engineer of the Phoenix Iron Co., of Phoenixville, Pa., has opened an office as a consulting engineer in the Hudson Terminal Bldg., 50 Church St., New York City. He will give special attention to foundations and to structural steel work for bridges and buildings.

Mr. C. deVere Fairchild, Assoc. M. Can. Soc. C. E., who has been connected with the Grand Trunk Pacific Ry.'s engineering department since the commencement of the first surveys, for the past three years as Terminal Engineer at Ft. William, Ont., has resigned and has retired for the present to his plantation on the Isle of Pines. It is rumored that a belt railway may be built on the island which will engage his attention in the near future.

Mr. Howard G. Hetzler has been made President of the Chicago & Western Indiana R. R. Mr. Hetzler graduated at the University of Michigan in civil engineering in the class of 1886. From the year of his graduation until 1905 he was successively Division Engineer, Roadmaster and Division Superintendent in the employ of the Chicago, Burlington & Quincy R. R. In April, 1905, he was made President of the Metropolitan West Side Elevated Ry. in Chicago.

Obituary.

I. M. Ludington, a railway contractor of Rochester, N. Y., died Jan. 27. He was the senior member of the firm of I. M. Ludington & Sons.

William Bradley Rising, Professor Emeritus of Chemistry in the University of California, died Feb. 9 at his home in Berkeley, Cal. Professor Rising was born at Mechlenburg, N. Y., in 1839 and graduated at Hamilton College in the class of 1864. He took a degree in mining engineering at the University of Michigan in 1867 and the degree of Ph. D. at Heidelberg, Germany, in 1871. His particular field of research was thermal chemistry and the chemistry of explosives. He had occupied the chair of chemistry at the University of California since 1872. At the Columbian Exposition in 1893 and again at the Paris Exposition in 1900, Professor Rising was a member of the jury of award.

Thomas Robinson, a retired U. S. Assistant Engineer, died Feb. 1 at Irving, Tex. Mr. Robinson was born in England in 1843. After serving for several years as a seaman along the coast of Labrador, he took up preparatory studies at Kimball Union Academy, Meriden, N. H., and later graduated at Amherst College. During the Civil War, he acted as messenger for the Christian Commission. He became an instructor in mathematics at Howard University, Washington, D. C., soon after its organization in 1867. He left this position in 1887 to become a U. S. Assistant Engineer. While in the Government service he constructed river and harbor improvements in Georgia and Florida, fortifications in Maine and storage reservoirs in Minnesota.

William H. Bailey, Manager of the steel mill of the Whitaker-Gleffner Co., of Wheeling, W. Va., died in that city Feb. 9. Mr. Bailey was born in Pittsburg, Pa., 66 years ago and was educated in the Pittsburg public schools. He remained in Pittsburg until 1892 and for a number of years he was manager of the old Republic Iron Co.'s mills on the south side. He removed to Muncie, Ind., in 1892 to become Superintendent of the mills of the Midland Steel Co. Four years later he went from Muncie to Piqua, Ohio, as Superintendent of a sheet metal plant and remained in this position five years. His next position was that of Superintendent of the American Sheet & Tinplate Co.'s plant at Canal Dover, Ohio, where he remained until, in 1904, he removed to Wheeling to take up the position he occupied at the time of his death.

Jackson Smith, Vice-President and General Manager of the Oregon Trunk Line R. R., and formerly a member of the Isthmian Canal Commission, died Jan. 28 at Portland, Ore. Mr. Smith was born in Marion, S. C., in 1862, and was educated at the Marion Academy. He entered railway service at the age of 14 and held various clerical positions with the Atlantic Coast Line, the Associated Rys. of Virginia & the Carolinas and the Louisville & Nashville R. R. until April, 1901, when he entered the employ of J. P. McDonald & Co., railway contractors, in New York City. In December of the following year, he became Assistant to the President of the Mexican International R. R. at Durango, Mex. He left this position in July, 1904, to become General Passenger Agent of the National Lines of Mexico. His successful experience while with the Mexican railways in recruiting and handling tropical laborers obtained for him in July, 1905, the appointment as assistant to the Chief Engineer (John F. Wallace) of the Panama Canal. Shortly after his arrival on the Isthmus, he was made Manager of the branch of labor and quarters and, in November, 1906, he was put at the head of the department of labor, quarters and subsistence. He became a member of the Isthmian Canal Commission in March, 1907, and resigned in September, 1909, when he was appointed Vice-President and General Manager of the Oregon Trunk Line.

George H. Thomson, M. Am. Soc. C. E., died at his home in Syracuse, N. Y., of heart disease after a brief illness. Mr. Thomson was 62 years of age. He began engineering work in Syracuse about 1865. After a short time he went South and was engaged in government work and general engineering in Louisiana, Mississippi and other southern states. On his return to the North he became connected with the New York Central & Hudson River R. R. and was Bridge Engineer of the road for many years. It was while holding this position that he attained a wide reputation in the profession. He was among the earliest engineers in the United States to advocate and construct riveted truss bridges in place of pin-connected, to make a large use of plate-girders, and to adopt solid-floor structures. Many of the bridges built by Mr. Thomson are still in service on the New York Central lines. After his retirement from the position of Bridge Engineer, he was for some time Consulting Engineer to the Bridge Department of the New York Central. He was also for a time a partner in a contracting firm in New York City, and in recent years had had a consulting engineering practice. At the time of his death he was connected with the New York Barge Canal construction.

Mr. Thomson was a man of strong personality and influence, and peculiar in many of his ideas relating to engineering matters. He contributed some notable papers to the transactions of engineering societies of which he was a member, and to engineering journals. He became a member of the American Society of Civil Engineers in 1887, and he was one of the earliest American engineers to be elected to membership in the Institution of Civil Engineers of Great Britain. Mr. Thomson is survived by a widow, six daughters and a son. The latter is engaged in engineering work with the Boston & Albany R. R.

Engineering Societies.

COMING MEETINGS.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.
Feb. 18-21. Annual convention at Chicago, Ill. Chairman, notification committee, O. U. Miracle, Minneapolis, Minn.

NATIONAL ASSOCIATION OF CEMENT USERS.
Feb. 21-26. Annual convention at Chicago, Ill. Pres., Richard L. Humphrey, Harrison Bldg., Philadelphia, Pa.

ENGINEERING SOCIETY OF WISCONSIN.
Feb. 23-25. Annual meeting at Milwaukee, Wis. Secy. W. G. Kirchoffer, 31 Vroman Bldg., Madison, Wis.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Feb. 24-26. Annual meeting at Chicago, Ill. Secy., D. J. Hauer, 721 Park Row Bldg., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
March 1-5. Annual meeting at Pittsburg, Pa. Secy., R. W. Raymond, 29 West 39th St., New York City.

ILLINOIS WATER SUPPLY ASSOCIATION.
March 8-9. Annual meeting at University of Illinois, Champaign, Ill. Secy., Edward Bartow, Urbana, Ill.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 15-17. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago, Ill.

AMERICAN WATER WORKS ASSOCIATION.
April 26-30. Annual convention at New Orleans, La. Secy., J. M. Diven, 14 George St., Charleston, S. C.

BROOKLYN ENGINEERS' CLUB.—At the meeting of Feb. 10, Mr. Percy C. Barney presented a paper entitled "The Catskill Water System of the City of New York."

WESTERN RAILWAY CLUB.—At the monthly meeting in Chicago, Ill., Feb. 15, the subject for discussion was the paper on "The Development of the Gas Engine," by Mr. E. T. Adams.

PAVING SPECIFICATION CONVENTION.—The first national convention of city officers and engineers for the purpose of standardizing paving specifications is to be held at Chicago, Ill., Feb. 21-26. Representatives are expected from 40 cities, including Pittsburg, Salt Lake City, Milwaukee, Wilmington, Green Bay, Minneapolis, St. Paul, New Orleans, Kansas City, Dayton, Des Moines, Newark and Nashville.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—At the regular monthly meeting held in New York City Feb. 11, Mr. W. Lee Campbell, of Chicago, Ill., presented a paper on "Modern Automatic Telephone Apparatus." A complete installation, consisting of a working automatic switchboard of 25 lines, with line switches, first selector switches and connector switches was shown connected up for service so that calls could be made from one telephone to another as in actual operation.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Prizes for the year ending in July, 1909, have been awarded as follows: The Collingwood prize for juniors to H. L. Wiley, Sunnyside, Wash., for his paper on "Sinking Piers for the Grand Trunk Pacific Bridge at Fort William, Ontario"; the Norman medal to J. A. L. Waddell, Kansas City, Mo., for his paper on "Nicket-Steel for Bridges"; the Thomas Fitch Rowland prize to W. J. Wilgus, New York City, for his paper on "Electrification of the Suburban Zone of the New York Central & Hudson River R. R."

AMERICAN INSTITUTE OF MINING ENGINEERS.—The sessions of the Pittsburg meeting, beginning March 1, will be held in the lecture room of the Carnegie library. Nominations for officers and members of the council to be elected at the annual business meeting in New York City, Feb. 15, are announced as follows: President of the council, D. W. Brunton, Denver, Colo.; Vice-Presidents of the council, Benjamin B. Lawrence, New York City; Albert Sauveur, Cambridge, Mass., and Joseph W. Richards, South Bethlehem, Pa.; councilors, Wm. Kelly, Vulcan, Mich., and Chas. F. Rand, New York City.

An excursion to Japan is planned for the months of October and November, 1910. It is estimated that the cost of the trip from San Francisco for each person will not exceed $500.

ILLINOIS WATER SUPPLY ASSOCIATION.—Among the papers to be presented at the annual meeting at Champaign, Ill., March 8-9, are the following: "Experience With Deep Well Pumps," F. C. Ainsbury, Champaign, Ill.; "Relation Between Typhoid Death Rate and Water Supplies of Illinois," Edward Bartow, Urbana, Ill.; "Water Supplies from Lake Michigan," W. C. Bouton, M. D., Waukegan, Ill.; "The Operation of Mechanical Filters," J. H. Brewster, Indianapolis, Ind.; "The Possibility of Pollution of Shallow Wells," C. B. Burdick, Chicago, Ill.; "Quality of the Waters of the Mississippi System," R. B. Dole, Washington, D. C.; "Legislation in Relation to Stream Pollution," H. M. Ely, Danville, Ill.; "A State Bureau of Municipal Information," J. W. Garner, Urbana, Ill.; "Use of Ozone in Treatment of Western Waters," W. F. Monfort, St. Louis, Mo.; "Action of Mississippi River Water on Metals," W. F. Monfort, St. Louis, Mo.; "Filtration of Water Supplies," J. L. Pearse, Chicago, Ill.; "Water Works Franchises," M. H. Robinson, Urbana, Ill.; "A City Water Supply from Shallow Wells," O. T. Smith, Freeport, Ill.; "Rate of Flow of Water into Wells," A. N. Talbot, Urbana, Ill.; "Comparison of Hydrated Lime With Ordinary Lime in Water Treatment," C. E. Thomas, Chicago, Ill.; "Should Water Companies Furnish Private Services Free to Patrons Up to and Including the Meters?" E. P. Wheeler, Lake Forest, Ill.; "Significance of the Term Alkalinity in Water Analysis and the Determination of Alkalinity by Means of Indicators," E. W. Washburn, Urbana, Ill.; "Disinfection of Water," C. E. A. Winslow, Boston, Mass.; President's Address, Dabney H. Maury, Peoria, Ill.